RADIO *and* ELECTRONICS

TELEVISION - COMMUNICATIONS - SERVICE - SOUND

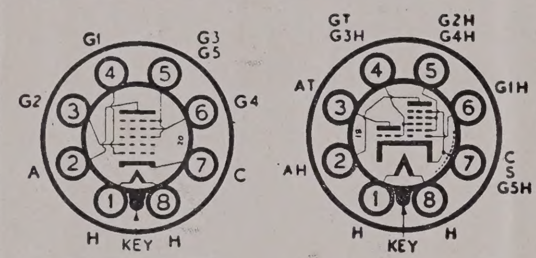
MARCH 1st, 1954

VOL. 9, NO. 1

BETTER LISTENING
BETTER *BRIMARIZE

Types 7A8 and 7B8 are frequency changers of similar classes, the former being an octode and the latter a heptode. The suppressor grid (G6) fitted to the 7A8 results in higher anode impedance and increased gain.

In A.C. and car radio receivers, both valves may be replaced by the 7S7, whilst in A.C./.D.C. receivers the 7A8 must be replaced by the 14S7 owing to its low heater current of 0.15 amp. In 12-volt car radios using the 7A8, replacement by type 7S7 will necessitate the fitting of a balancing resistor in the heater circuit.



Types 7A8, 7B8
(7A8 has G6 connected to Cathode)

Type 7S7

CHARACTERISTICS

TYPE	7A8	7B8	7S7*	
Heater Voltage	6.3	6.3	6.3	volts
Heater Current	0.15	0.3	0.3	amp.
Anode Voltage	250	250	250	volts
Screen Voltage	100	100	100	volts
Osc. Anode Resistor	20,000	20,000	20,000	ohms
Bias Resistor	300	300	200	ohms
Impedance	0.7	0.36	1.25	Meg.
Conversion Cond.	0.6	0.55	0.53	mA/v

*Type 14S7 is identical to type 7S7 except for its heater ratings of 12.6 volts, 0.15 amp.

VALVE TYPE FROM	VALVE TYPE TO	CHANGE SOCKET	CHANGE CONNECTIONS	OTHER WORK NECESSARY	PERFORMANCE CHANGE
7A8	7S7 (14S7 in AC/DC sets)	Loctal (B8G) NO CHANGE	NO CHANGE	1. Re-align Receiver. 2. 12-Volt car radios —fit balancing resistor in heater circuit. See *note.*	NEGLIGIBLE
7B8	7S7	Loctal (B8G) NO CHANGE	NO CHANGE	Re-align Receiver.	NEGLIGIBLE

Note: (7A8 only). In 12-volt receivers where pairs of valves are connected across the 12-volt supply, the valve connected in series with the 7S7 must be fitted with a 40 ohm 2 watt resistor across its heater terminals.

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TELETUBES

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—a manoeuvre executed by qualified radio engineers in order to effect the widest possible use of available BRIMAR VALVES.

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Radio and Electronics

OUR COVER:

A view of the control room in the Pye television studio at the recent Wellington Industrial Fair.

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TV. Development in Britain

In November of last year, the British Government issued a White Paper setting out its policy for the development of commercial television in that country. Now, this might not seem at first sight to be an earth-shaking event; it is at least significant, and we hope that its meaning will not be lost on those who, in theory at least, are considering all matters relevant to the establishment of television in this country.

The really unusual part of the White Paper is the fact that it exists at all, for, in Britain, television broadcasting is at present the monopoly of the B.B.C., and the scheme for commercial broadcasting suggested by the Government will, if put into practice, automatically bring that monopoly to an end. Briefly, the idea is to set up a new corporation, similar to the B.B.C., which will provide and operate a new chain of television stations. It will not, however, provide the programmes. These would be provided by privately financed companies, who will be allowed to draw revenue from advertisements which would form part of the programme material. The corporation, in addition to providing the station facilities and operating them, would have certain powers which would enable it to control, to some extent, the programmes presented by the "programme" companies. These powers would be as follows:—

(1) The corporation could call for programme schedules and scripts in advance.

(2) It could require the programme companies to make sound and vision records of programmes for subsequent examination.

(3) It could forbid the broadcasting of certain types of matter.

(4) It could regulate advertisements.

These powers are thought by the British Government to provide an adequate measure of control, while allowing the programme companies almost complete freedom in their choice of programme material.

It is clear that the idea behind the establishment of the new corporation is mainly that of allowing commercial television to compete for viewers with the B.B.C., to the advantage of both, but at the same time preventing the commercial programmes from reaching the very low level of entertainment value that obtains in America. As the White Paper points out, there is a vast difference between giving advertisers the right to dictate what kinds of programme shall be used and allowing them to insert advertisements into a programme which is no direct concern of theirs, provided it attracts enough viewing support. The argument is that if newspapers sell advertising space, they also determine what shall be printed in their own news and editorial pages. Why, then, should the purchasers of advertising "space" on a television station be allowed to determine what the programmes contain? The argument is based, of course, on the fact that in America the programmes are, in effect, provided by the "sponsors," because these gentlemen will not pay to present programmes which they themselves do not think will attract enough viewers. As a result, the programmes are brought down to the lowest common denominator of public taste, on the principle that what will appeal to the least intelligent and least educated members of the public must therefore attract the largest numbers. One has only to compare the quality of the average commercial radio serial with that of those the B.B.C. produces to realize what could happen to commercial TV programmes!

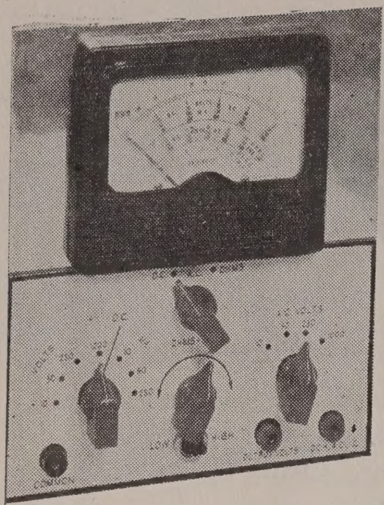
It is no doubt for this reason that our own Government has set its face against any form of privately-run television for this country, without having given the matter very much thought. It is certainly a laudable enough idea, but, in using it as a reason for not considering any but a State-owned and run TV system, the Government has side-stepped a good many issues which are considerably more important. Where, for instance, is its enthusiasm for private enterprise? It would have been understandable for the Opposition to have opposed any attempt on the part of private enterprise to break into such a national enterprise as television, but this is not the attitude to have been expected from the present Government.

There seems to be little doubt that our own Government's reluctance to have anything to do with TV as a State-owned venture is bound up in financial considerations, and even some of TV's most ardent protagonists ask the question, "Where is the money to come from?" when the opening of a service is mentioned. It seems to us, however, that a practicable answer is to be found in the same White Paper we have been discussing above.

The British Government's proposals for financing the new corporation are that it should be provided with the necessary capital—about half a million pounds, initially, for setting up three stations immediately—by advances from the Treasury, at rates of interest and repayment to be decided. The advances would be repaid from revenue obtained by letting contracts to the programme companies. If the corporation should make a profit, this would be retained in order to reduce the need for future borrowing from Treasury.

Now, although the circumstances are not by any means the same here as they are in Britain, there does not seem to be any basic reason why some such scheme should not be used to establish television in New Zealand. There is little doubt that the advertising revenue would be forthcoming, even in the early stages when viewers were relatively few and far between. Experience elsewhere has shown that commercial television, unlike crime, does pay. It may not pay overnight, but, given a reasonable initial period of, say, ten years, it seems very unlikely that the public purse would be any the leaner. Indeed, it would have been swelled by the interest paid by the corporation! In the meantime, the public would have acquired TV as the most powerful modern medium of home entertainment, and one of our most flourishing secondary industries would have received a well-deserved fillip.

Test Equipment for the Amateur—No. 3



An Easily Constructed Multi-Meter

This article describes a multi-range volt-ohm-milliammeter which is not extremely complicated, as are many commercial instruments, and which can be built in stages if desired. It can be built for a good deal less than ten pounds, and will give all the accuracy needed for servicing or for the checking of newly-built equipment.

INTRODUCTION

No one who indulges in radio work, either professionally or as a hobby, can really afford to be without some means of measuring the voltages and currents in the gear that he builds or has to repair. If a new piece of equipment appears to work properly at first turning on, so much the better, but this happy state of affairs does not always occur, and it is then that one feels the need for test equipment, however elementary. Perhaps the item that can least easily be dispensed with is the common-or-garden multi-meter. It cannot only be of the greatest assistance in finding faults in things that do not work properly, but also can help the builder to ensure that everything is really well with his newly built set or amplifier, even when it appears to be working properly. For instance, without the aid of a meter, who can tell that the operating voltages are correct, and that the valves are not being run outside their ratings inadvertently? It has not been unknown for a power transformer, for example, to be sold as a 350v.-a-side, when in reality it is 385v.-a-side. A set or amplifier built with it would certainly run with considerably more than the rated H.T. voltage unless the mistake were discovered, and this would almost certainly result in short valve life, and other probable faults such as the breaking down of electrolytic condensers before their time. A check with the meter, however, would reveal that the voltage on the H.T. line was much greater than it should be, whereupon the search could take place to find the reason. This is but one example of the use of a meter, even when things appear to be functioning perfectly, and should things like this occur, it would not be long before the price of a meter would be expended in replacing parts that should never have broken down in the first place.

What we are trying to get over is the fact that not to have a multi-meter of some sort is really false economy. But even if this is granted as true, it does not alter the fact that commercial instruments are expensive. For the professional man this fact is just one of the things he must be prepared to put up with, but for the amateur, it usually results in his refraining from buying a meter of any sort.

It is for this reason that we have designed and built the instrument described in this article. It can be put together easily by anyone who can follow a circuit diagram, and has been designed to have several features that will appeal to the amateur constructor.

FEATURES OF THE INSTRUMENT

Before we go any further, it would be as well to give the specifications of the multi-meter, and to outline some of its special features:

(1) It has ranges covering D.C. and A.C. volts, D.C. milliamperes, and ohms.

(2) D.C. voltage scales are: 0–10, 0–50, 0–250, and 0–1,000v.

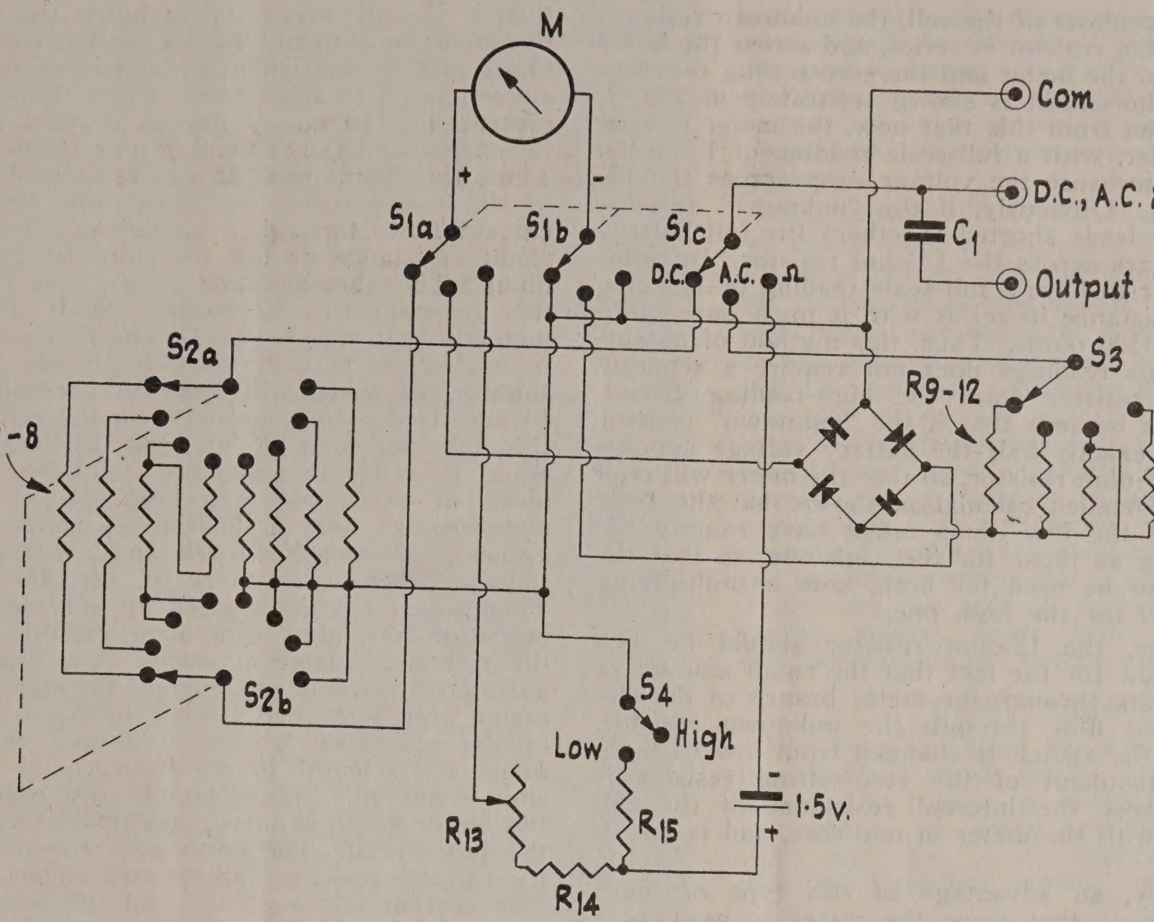
(3) D.C. current scales are: 0–10, 0–50, 0–250, and 0–1,000 ma.

(4) A.C. voltage ranges are the same as the D.C. ranges.

(5) Ohms ranges are 0–1,000 and 0–100,000 ohms.

(6) The D.C., A.C., and ohms circuits are entirely separate from each other in their wiring, so that any portion or portions can be built without the remaining ones. In this way, builders are not constrained to build the whole circuit, but can choose only those portions they feel they need. At the same time, it is possible to add the remaining sections later without undoing any of the work already carried out.

A glance at this list will show that no attempt has been made to make the ranges absolutely comprehensive, or to include any facility that anyone might possibly want. It is only in this way that undue complication can be avoided, and in doing this, we have left out those facilities which were felt to be least required. For example, one rarely has any need to measure alternating currents in radio work, so that A.C. current ranges have been omitted altogether. Similarly, a high-ohms range has been left out, because in radio work it is seldom necessary to know the values of resistors greater than 100k. with any accuracy. On the other hand, a reasonably low-reading range was included, because it is so useful in checking components. The low ohms range reads 15 ohms at the centre of the scale, and from 0 to 5 ohms occupies almost a quarter of the scale. This makes the range ideal for checking such things as R.F. and I.F. coils where these are suspected of things like partial short-circuits. It also makes it easy to make one's own low-value resistors from bits of resistance wire, for such purposes as drop-



ping resistors for running a 4.0-volt valve or cathode ray tube from a 6.3v. heater winding.

HOW THE CIRCUITS ARE SEPARATED

Reference to the circuit diagram shows that there are three switches. One is a three-pole, three-position switch, whose job is to isolate the D.C., A.C., and ohms circuits. This it does by using two poles to switch the leads to the meter itself, and a third to switch the "hot" test prod. It might be thought that a fourth pole would be needed to switch the "common" test prod, but this is avoided by tying together the common sides of the D.C. and ohms circuits, and one side of the meter rectifier in the A.C. circuit. Apart from this one lead, the circuits are quite separate. To operate the meter, therefore, the main switch is placed in the appropriate position—D.C., A.C., or Ohms, after which one of the other switches is used to select the desired range. On D.C., the voltage multipliers and current shunts have all been wired to the same switch, which is a double pole one, but since the A.C. ranges are confined to measuring voltages, a single-pole switch suffices here, with one end of all the resistors tied together.

THE OHMS RANGES

If the circuit is traced on the High Ohms range, it will be seen that all we have is the 1.5v. cell in series with the meter, the test prods, and the zero-setting resistor. In the multi-scaled meter that was used, the ohms scale is marked so as to read directly on the low-ohms range, and to indicate scale reading multiplied by 100 on the high ohms range. Thus, in the centre of the scale, the measurement is 1500 ohms on the high range. Since a 1.5v. cell is used, the total resistance in circuit must be 1500 ohms when the test prods are shorted and the variable resistor is adjusted for full-scale deflection, since 1.5v. across 1500 ohms gives a curernt of 1 ma. The zero-setting resistor is thus made up of 1000 ohms fixed, in series with a 1000-ohm rheostat, giving full-scale meter deflection at approximately half rotation of the latter.

The scheme used to obtain a low-reading ohms scale is very simple. The switch connects a resistor of approximately 15 ohms from one side of the meter to the positive side of the 1.5v. cell. The measuring

COMPONENT LIST

S_1, 3-pole, 3-position wafer, A.C., D.C., ohms selector.
S_2, 2-pole, 8 or more positions, D.C. range selector switch.
S_3, single-pole, 4-position, A.C. range selector switch.
R_1 to R_8 (left to right):
R_1, 10k 1 per cent.; R_2, 50k. 1 per cent.; R_3, 250k. 1 per cent.; R_4, 750k. 1 per cent.; R_5, 11.1 ohms (10 ma. shunt); R_6, 2.04 ohms (50 ma. shunt); R_7, 0.40 ohms (250 ma. shunt); R_8, 0.10 ohms (1 amp. shunt).
R_9 to R_{12} (left to right):
R_9, 10k. 1 per cent.; R_{10}, , 50k. 1 per cent.; R_{11}, 250k. 1 per cent.; R_{12}, approx. 600 to 750k. Note.—this resistor will vary with the individual rectifier unit used, and will have to be adjusted until the 1,000v. range agrees with the 250-volt one.
C_1, 0.1 μf. 400v. (or higher rating).
Metal rectifiers—war-surplus bridge-connected meter rectifier.
R_{13}, 1,000 ohm pot.
R_{14}, 500 ohms.
R_{15}, 14.8 ohms.

circuit then consists of the cell, the unknown resistor, and the 15-ohm resistor in series, and across the latter are connected the meter and the zero-setting resistors in series. The circuit is shown separately in Fig. 2. It can be seen from this that now, the meter is used as a voltmeter, with a full-scale reading of 1.5 volts, in order to measure the voltage drop across the 15-ohm resistor. Obviously, if the "unknown" resistor is zero (test leads shorted together) the full battery voltage appears across the 15-ohm resistor. In order for the meter to have a full-scale reading of 1½ volts, the total resistance in series with it must once more be equal to 1500 ohms. Thus, this method of obtaining low ohms readings does not require a separate zero-setting resistor from the high-reading circuit. Again, it can be seen that if the "unknown" resistor is 15 ohms, exactly half the battery voltage appears across the 15-ohm resistor, so that the meter will read half scale. Detailed calculation shows that the scale divisions for the low ohms range have exactly the same spacing as those for the high one, so that the one scale can be used for both, with a multiplying factor of 100 for the high one.

In practice, the 15-ohm resistor should be 14.8 ohms, to allow for the fact that the small amount of current flowing through the meter branch of the circuit does not flow through the unknown resistor. Also, when the switch is changed from low to high, a slight adjustment of the zero-setting resistor is needed, because the internal resistance of the cell is in series with the meter in one case, and is not in the other.

Incidentally, an advantage of this type of ohm-meter circuit is that since the meter is used as a voltmeter, any type of meter may be used, since the readings do not depend on the resistance of the movement, provided the zero-setting resistor is adjusted for full-scale deflection with the test prods shorted.

VALUES OF COMPONENT PARTS

Since a 1ma. meter is used, the sensitivity of the multimeter on voltage ranges is 1000 ohms per volt. This means that for obtaining a particular voltage scale, the total resistance in circuit must be 1000 times the desired full-scale voltage. For example, for a full-scale deflection of 10 volts, the total resistance must be 10,000 ohms. But since the meter coil itself has some resistance—100 ohms in the case of the meter illustrated—the series resistance required is only 10,000 — 100 = 9,900 ohms. In a meter which had to be accurate to within a small fraction of one per cent, it would be necessary to see that this was the actual value of series resistor used, but here, the inaccuracy involved in forgetting about the 100 ohms meter resistance is so slight that we can use a 10,000-ohm resistor. Readers will notice that we have specified a tolerance of plus or minus 1 per cent for the multiplier resistors. This has been done, because such resistors can now be obtained in New Zealand, and the small additional cost is as nothing compared with the effort of obtaining accurate resistors from ordinary tolerance ones by filing!

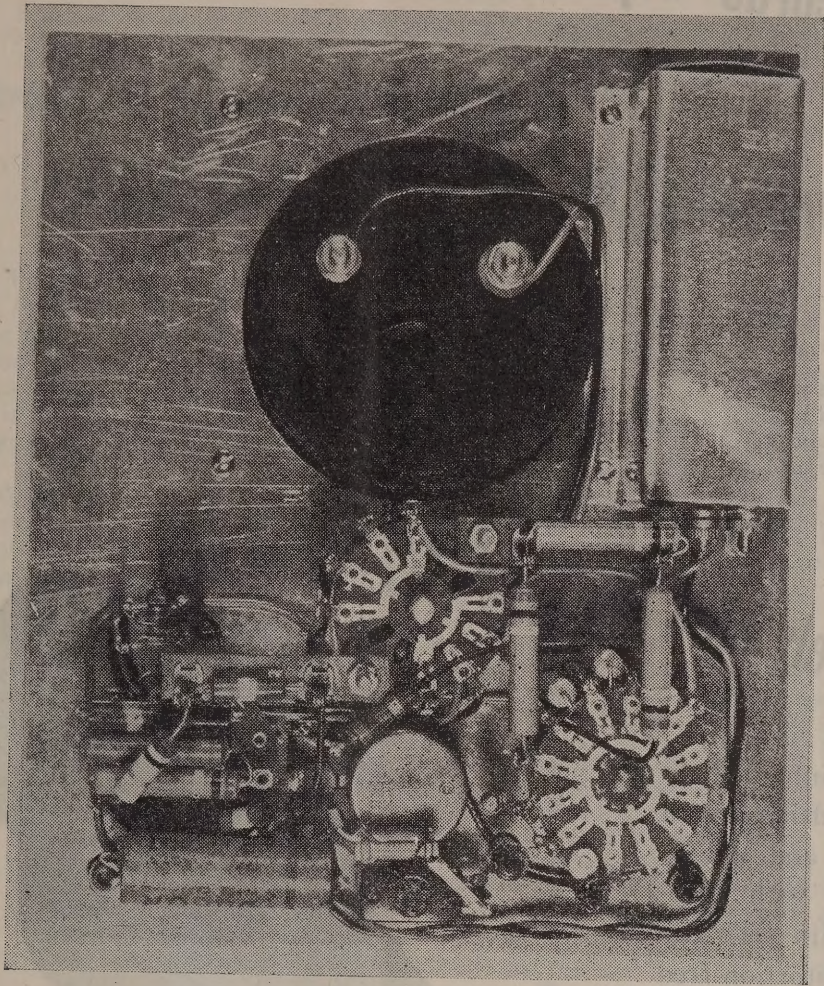
As for the current shunts, these can be purchased to suit the multi-scale meter illustrated in the photographs. It is considerably cheaper, if less accurate, to make one's own shunts. For the lower ranges, this presents little difficulty.

MAKING HOME-MADE SHUNTS

The first step in shunting a meter so that its full-scale reading is multiplied by a given amount is to work out the resistance of the required shunt. To do this, it is only necessary to know the resistance of the meter movement. In the present case, this is 100 ohms, and the first shunt to be made is for a full-scale deflection of 10 ma. Thus, when the current to be measured is 10 ma., 1 ma. of it must flow through the meter, and the remaining nine through the shunt. Thus, the shunt must have a resistance of one-ninth of the meter resistance, since nine times as much current flows through it as through the meter. The shunt resistance should therefore be 100/9 = 11.11 ohms. The question now arises, how is a shunt of this resistance to be made? Well there are two methods that may be used. The first and better one, is to borrow a meter which already has accurate shunts, and which will give an accurate reading of 10 ma. It does not matter if on the reference meter, this does not come at full scale, as long as it can be read. In order to make the shunt, we take a small piece of resistance wire—say 24 or finer gauge nichrome, as used in heating elements—a source of current, such as a No. 6 cell, and a wire-wound potentiometer with a resistance of, say 200 ohms or so. Then a test circuit is wired up, placing the cell, the potentiometer, used as a plain variable resistor, and the reference meter in series. The resistor is then adjusted to give 10 ma. current through the reference meter, and the circuit is broken. Next, a small piece of the resistance wire is measured with the ohm-meter and a length giving as nearly 11 ohms as possible is cut off. This is temporarily connected across the meter to be shunted, and this is now wired into the test circuit. The latter now consists of the cell, the variable resistor, and the two meters, all in series. The current is turned on, and the resistor adjusted so as to give exactly 10 ma. through the reference meter. If the shunt for the other meter is correct, it will read exactly full scale. If the resistance of the shunt is too high, the reading will be too low, and vice-versa. The length of the shunt wire can be adjusted until the two meters agree exactly, after which the wire can be wound on a former, and inserted into the circuit. A suitable former is a 1-watt resistor of high value, the leading making excellent tie-points for the wire as well as serving as connectors in the ordinary way.

The remaining shunts can be made in similar fashion. The shunt for 50 ma. should have a resistance of 100/49 ohms, which is so close to 2 ohms as not to matter, while a shunt of 0.4 ohms will be needed for the 250 ma. range. For the 1 amp. range, the shunt has to be only 0.1 ohm, and adjusting it is likely to be rather tricky, so that if you plan to include this range, it would be advisable to buy one of the commercially available shunts.

An alternative way of making the shunts is as follows. This method does not involve the use of a separate meter as a standard, but is less accurate, since it depends on the accuracy of reading of the meter used. To make the 10 ma. shunt, we first hook up a temporary circuit consisting of a battery, the meter, and some adjustable series resistance, just as for an ohm-meter circuit. The series resistance is adjusted so that the meter reads exactly full scale. This gives a current of exactly 1 ma. if the meter is exact. Then, without touching anything, the shunt wire is connected across the meter terminals, and is adjusted in length until the reading is exactly one-tenth of full-scale. Obviously, when this is done, the new full-scale reading must be ten times the original, provided only that the meter is consistent from one part of its scale to another. That is to say, the cur-



rent required to give one-tenth of scale deflection must actually be one-enth of the F.S.D. current. We tend to assume automically that this is so, and first-class meters are quite accurate in this respect, but by no means all meters respond as linearly as their linear scale would have us believe!

After making the 10 ma. shunt in this way, we can proceed to make the 50 ma. shunt in the same manner, this time using the meter on the 10 ma. range, and making a shunt which will reduce the full-scale reading to a fifth of full scale when the shunt is connected. It will be seen that proceeding progressively in this way causes any errors that may creep in to be cumulative, because for each shunt we have to use the one previously made, assuming it to be correct, whereas in fact it must have some slight error. However, we are not attempting to make a sub-standard meter. If we end up with something that is acurate to withnn 3 per cent. we will be very lucky, and for routine testing work, better than 5 per cent. accuracy is not strictly necessary.

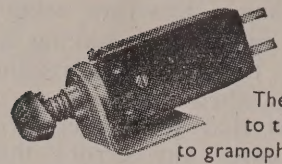
CONCLUSION

We have attempted to give slightly more than the bare circuit details, so that if anyone wishes to use a different movement, or wants to make modification which will suit his own requirements better than our standard circuit, he should have

(Concluded on page 44.)

for either standard or L.P. records — just turn the knob !

balanced, distortion-free reproduction



The G.P. 29-2 cartridge as fitted to the G.P.30 pick-up is available to gramophone and radio manufacturers. Leading makers already fit it in very large numbers.

extremely kind to records

The G.P.30 crystal turnover pick-up is intended to provide the largest number of record enthusiasts with the best possible reproduction of standard and micro-groove records when used in conjunction with commercial equipment such as the normal radio set. The output characteristics give balanced distortion-free reproduction with minimum surface noise. And the use of this Pick-up ensures long record life; the careful design gives exceptional tracking capabilities at the low stylus pressure of ten grammes.

the Acos GP30

turnover crystal pick-up

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Circuits for the Experimenter No. 1

OBTAINING HIGHLY ACCURATE PUSH-PULL BALANCE

There are very many types of phase inverter circuit in common use, but not all of them give results which are good enough for the most exacting requirements. The one which springs first to mind is, of course, the phase inverter for a high-quality amplifier, for here it is of considerable importance to have well-balanced signal voltages. Especially is this so when there is to be a large amount of negative feedback round the amplifier. Another application where good balance is important is that of the phase inverter in oscilloscope amplifiers. Here, unbalance is likely to introduce phase shift as well as amplitude unbalance, and it is well known that the effects of phase shift on a visual presentation such as a 'scope picture are much more drastic than where the presentation is purely aural. The question is, how can unbalance be corrected? If it can be, then the necessity for highly accurately balanced outputs from the phase inverter is removed. The circuit shown in Fig. 1 represents a solution developed by Parnum, and originally described in "Wireless World" in January, 1945.

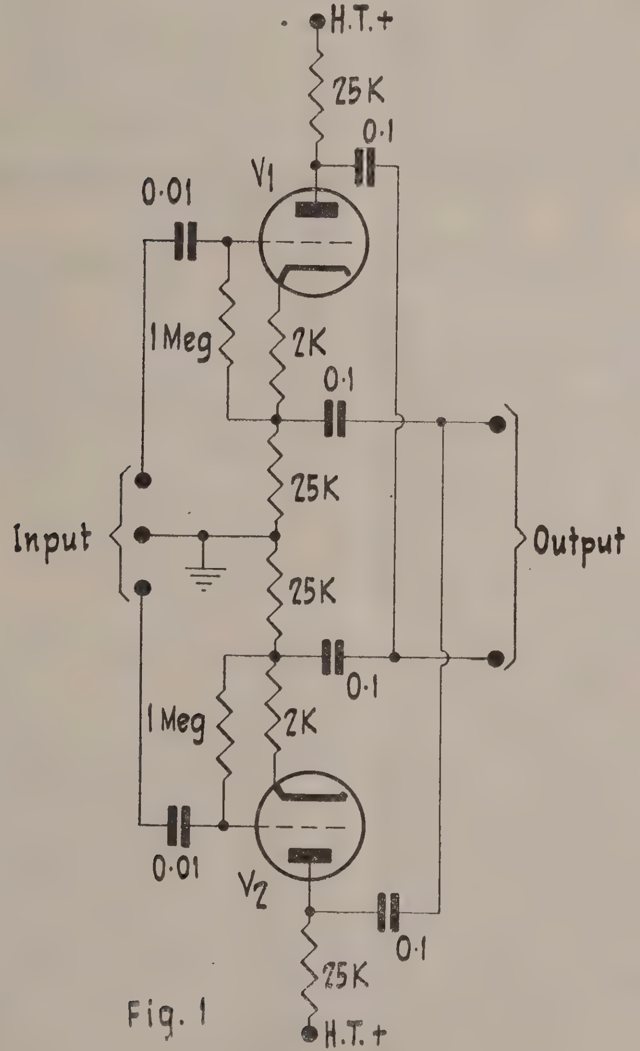

Fig. 1

It will be seen to consist of two triode circuits, which will be easily recognised as themselves being split-load phase inverters. The push-pull output of the phase inverter proper is fed to the two input terminals, while output, also in push-pull, is taken from the cathode load resistors. There is negative feedback from each triode plate to the upper end of the cathode load resistor of the other. These feedbacks act in such a way as to eliminate the in-phase components of the signal voltage, if any. The desired out-of-phase components are not affected at all. In this way, the stage is very similar to the output transformer of a push-pull amplifier, except of course, that one cannot obtain a single-ended output from the valve stage.

USING THE CIRCUIT

How, then, can the circuit be put to use? It can be inserted between the phase inverter and the output stage, or between the inverter and the first push-pull stage, if this is not the output stage. Since the outputs are taken from the cathode circuits of the valves, these are acting as cathode followers, and their gain cannot be greater than unity. In practice the signal at the cathode load resistor will be approximately 0.9 times the input signal. The slight loss is insignificant, and it is very helpful that there is no amplification, because it enables the circuit to be inserted in an existing valve line-up without sensibly affecting the overall amplification.

An advantage of using the circuit in a newly-designed amplier is that one is able to choose a phase inverter circuit which, in spite of other advantages, does not produce exactly balanced output voltages. One such phase inverter is the so-called "long-tailed pair." When the present circuit is used, the slight unbalance, characteristic of the conventional long-tailed pair circuit, is automatically compensated.

Amplifiers used in some special electronic instruments, such as electro-cardiographs and electro-encephalographs, depend for their success on exceedingly accurate push-pull balance. This circuit is sometimes used in such amplifiers, following each amplifier stage. In this way, any unbalances arising in the amplifier stages themselves are automatically cancelled out.

Altogether, the circuit has distinct possibilities for numerous applications of interest to amateur and professional alike.

* * *

AN EFFECTIVE BASS-CUT CIRCUIT

The parallel-T network is an arrangement of condensers and resistors which has one property usually associated only with tuned circuits containing inductance and capacity. It can be designed to have one frequency at which there is infinite attenuation—which is the same thing that characterises a tuned rejector circuit. However, like the tuned circuit, its performance is never theoretically perfect, but where the components are reasonably accurately chosen, the null is quite sharp, and very deep. In spite of this, the network does have some effect at frequencies quite widely removed from the "tuned" frequency. It can be used for rejecting a certain fixed frequency,

or, in a feedback amplifier, for emphasizing it. Here, however, the very high attenuation at one particular frequency is really incidental to the main purpose, which is to give relatively heavy attenuation over a rather wide band of frequencies. In Fig. 2 we have a circuit showing how the parallel-T network is ap-

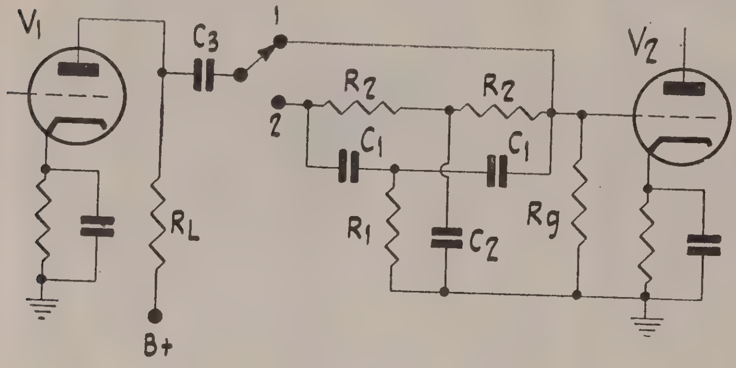

Fig. 2.

$C_1 = 0.002$ μf.	$R_1 = 2$ meg.
$C_2 = 0.008$ μf.	$R_2 = 2$ meg.
$C_3 = 0.1$ μf.	$R_g = 1$ meg.

plied. The output of one valve is applied to the input terminals, and the output of the network is applied to the grid of the next valve. A switch is included, by means of which the network can be excluded from the circuit if desired. Fig. 3 shows the frequency response of the network illustrated in the diagram. The "tuned" frequency, at which the attenuation is theoretically infinite, is 28c/sec., but it can be seen that the response starts to depart from flatness at a very much higher frequency. It is, in fact, 3db. down at about 325c/sec. However, there are many applications in which this kind of roll-off is not at all undesirable. For example, in a communications receiver, it is often essential to insert severe bass cut in order to restore readability, after a signal has suffered top cutting by the selectivity of the receiver. For communications work, and especially that on the amateur bands, it is particularly necessary to have bass cut available for use when necessary, because so many transmitters do not themselves attenuate the bass. Heavy bass in the signal, particularly when it is perforce received on highly selective receiver, can make the speech well-nigh unintelligible.

ALTERING THE CONSTANTS

If for any reason it is desired to shift the response curve bodily to the right or left, this can be done by altering the values in a systematic manner. For example, to double the frequency at which the network tunes, the resistors can be doubled, or the capacities halved. To reduce the frequency by a given factor, the resistances are divided by that factor or the capacities multiplied by the same factor. Note that only the one type of component is altered. If the resistors were halved, and at the same time the condensers were doubled, the frequency would remain the same.

Other things being equal, altering the values in the ways indicated above does not alter the shape of the response curve at all—only its position on the frequency scale. For example, if the resistors were halved in the network specified in Fig. 2, the

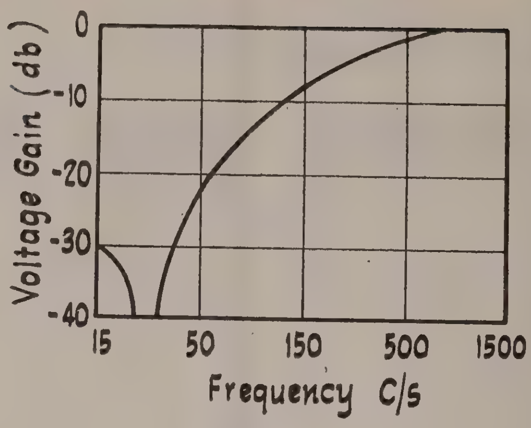

Fig. 3.

response curve would be correct provided the frequency markings on the graph were doubled also.

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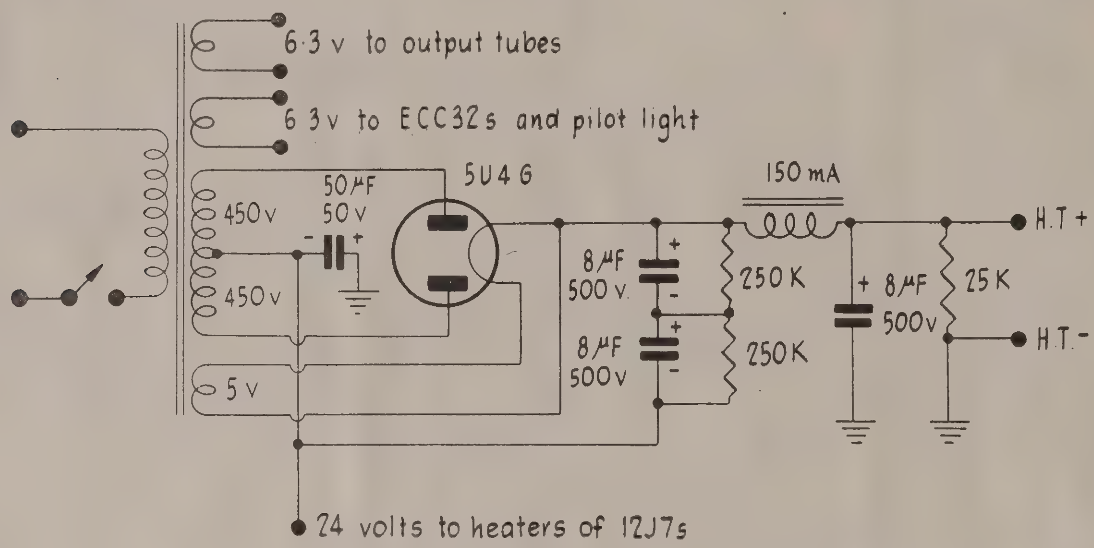
A Power Supply and Standard Pre-Amplifier for the "R. & E." 1954 High-Quality Amplifier

In "Radio and Electronics" of January, 1954, we printed full circuit details of the latest high-quality amplifier design to come from our laboratory. This article shows a suitable power supply, and a pre-amplifier circuit which can be incorporated on the main chassis, or built separately, as desired.



POWER SUPPLY

In the January article describing the "R. and E." 1954 High-quality Amplifier, we indicated that a power supply of approximately 450 volts output would be required to run it at full output. Allowing for voltage lost in the cathode bias resistors, and in providing heater power for the first stage, this means that the KT66 output valves will have their maximum rated plate-to-cathode voltage of 400. At this, the maximum undistorted power output will be in the vicinity of 15 watts, but there is little reason why, if the builder so desires, the size of the power supply, and thus the output power, should not be reduced. However, for the type of amplifier we have in this one, the requirements of the power supply are quite modest. It might be expected, for example, that extremely good power supply regulation would be required, but, in practice, such is not the case. Neither the regulation nor smoothing requirements are at all stringent, as a glance at the circuit given here will demonstrate, and this makes for a relatively simple and inexpensive supply. A 450-volt-a-side transformer is used, rated to deliver 150 ma. The amplifier draws almost exactly this amount of current, so that the transformer will be running fully loaded, but it is designed to take it, and it is unnecessary expense to put in a heavier one, under the impression that it will be all the better for running "light."

The rectifier is a 5U4G, but a 5Z3 can be used if one is available, since the two types are identical electrically, and differ only in their basing. The input condenser has a value of 4 µf., made up from two 8 µf. 450v. electrolytics in series. The voltage is just too high to allow a single one to be used, and the exceedingly hum-free nature of the amplifier makes it unnecessary to use a larger input condenser.

On no account should one forget to put in the balancing resistors, which can be seen in parallel with the electrolytics. These prevent one of the series pair, whose leakage may be particularly small, from developing the majority of the D.C. voltage across itself, and exceeding its voltage rating. Note, too, that the centre-tap of the power transformer is not earthed. It will be remembered that the first valve in the amplifier has its heater in the centre-tap of the power transformer. In this way, all the direct current supplied by the rectifier is passed through the valve's heater. The amplifier itself draws approximately 120 ma.; the 12J7 heater, however, needs 150 ma. At the same time, with a relatively heavy power supply like this one, it is essential to have a bleeder across its output terminals, to prevent the voltage rising excessively when the amplifier is first turned on and the power valves have not warmed up, or if the power supply is turned on accidentally without first having been plugged into the amplifier chassis. Thus a 25k. resistor is provided as a bleeder. The current through this is 18 ma., so that this, too, flows through the 12J7 heater, bringing its current up to very nearly the official 150 ma.

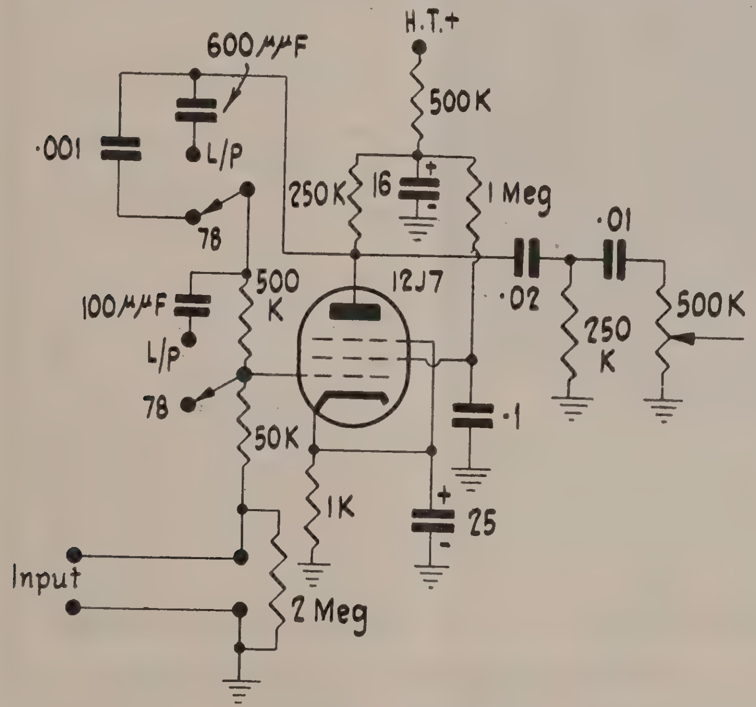
To avoid having to use a further pair of electrolytics in series for the second smoothing condenser, a 500v. working one was obtained, and was found to be perfectly satisfactory. These 500v. working electrolytics are not as common yet as they might be, but they are available in some shops. A little hunting to find one will be well repaid, since to make up 8 µf. using a series-connected pair will call for at least one extra condenser. If the 500v. working

condenser cannot be located, the best alternative is to use two 16 μf. 450v. working condensers in series, with 250k. balancing resistors in parallel with them, as in the input condenser shown.

The heaters of the amplifier take quite a lot of current—some 5½ amps. all told, so that it is best to employ both the windings that are normally supplied on a 150 ma. power transformer, using one of them for the KT66s, and the other for the ECC32s.

A SUITABLE PRE-AMPLIFIER

Although the main amplifier has quite high gain, being several times more sensitive than the Williamson, for example, it will still be necessary to provide a little pre-amplification for many types of pick-up. This is especially so, as all high-quality pick-ups that may be reckoned worthy to be used with an amplifier of this quality, require equalization for both standard and L/P recordings. Most of them, too, have quite small output voltages, so that an equalizer which has a useful amount of gain at the same time is a necessity. The circuit shown here is an ideal one for the purpose. We have shown similar circuits many times before in these pages, so that our regular



readers will find nothing novel about this one. We print it, however, because it uses a 12J7, and thus requires slightly different circuit values from the others that have appeared previously.

It is the now well-known feedback equalizer circuit which obtains bass boost for standard records, and both bass boost and top cut for L/Ps, by inserting small condensers in the feedback loop from plate to grid of a high-gain pentode amplifier. A two-position switch, with two poles, provides the different frequency responses needed for the two types of record. At frequencies at which the condensers in the feedback chain have no effect, the stage gain is approximately 10 times. However, because the blocking condensers from the plate to the grid circuit have been made small in value, the signal voltage fed back to the grid becomes smaller the lower the frequency; as a result, the stage gain increases, the lower the signal frequency. The point in the scale at which the boost starts to become effective is determined by the exact size of the coupling condensers. Since this frequency is lower for standard records than for L/P, the larger condenser is used in the 78 position of the switch.

L/P records, as well as having their bass response progressively reduced below about 500 c/sec., have their top response emphasized above about 2,000 c/sec. Consequently, the L/P equalizer must produce some top cut as well as bass boost. This is achieved by placing a condenser of the appropriate size across the feedback resistor of 500 k. The effect of the condenser is to increase the amount of feedback progressively at frequencies above 2,000 c/sec. thereby decreasing the gain in the same proportion.

The shunt condenser, labelled 100 $\mu\mu$f. in the diagram, is the only portion of the circuit that may need slight alteration to suit the characteristics of different pick-up heads. The reason for this is to be found in the fact that a pick-up is a predominantly inductive device. It is connected in series with the lower (50k.) arm of the feedback voltage divider, so that, being inductive, its impedance becomes higher the higher the frequency. This can cause the impedance of the lower arm of the voltage divider to increase somewhat at high frequencies. If this happens, the effect is again to increase the amount of feedback at high frequencies, giving an additional amount of top cut. Since this cannot be avoided, it must be compensated for by decreasing the amount of top cut given by the shunt condenser. No difficulty need be experienced on this account, however.

All that is necessary is that the exact size of the shunt condenser should be varied between the values of, say, 50 and 200 $\mu\mu$f., until the top response on L/P records matches that on 78s. With low-impedance magnetic pick-ups, the effect will be completely negligible, but it might be noticeable with a high-impedance magnetic head. In any event, it is unlikely to be noticeable except when a constant-frequency disc is used to measure the overall frequency response of the system. We doubt whether the ear could notice the difference unaided by instruments.

RUMBLE FILTER INCLUDED

Some turntables are not as good as others, and produce more mechanical rumble. This can be very annoying, and, if it is found so, there are only two solutions. The best but most expensive one is to buy a better turntable and motor, but a very good substitute, except in very bad cases, is to use a rumble filter. This is merely a network that starts to attenuate the bass response below 30 cycles or so without any noticeable effect on the music. One has been incorporated in the pre-amplifier, and it consists of a double R.C. coupling, using much smaller condensers than are customary. If anyone doubts that it has no effect on the music, we can only recommend him to try it, and we are sure he will be agreeably surprised at its effectiveness.

HEATER SUPPLY FOR THE PRE-AMPLIFIER

If the pre-amplifier is built on to the same chassis as the main amplifier, it is a good plan to use D.C. for its heater too. This is merely a matter of wiring its heater in series with that of the 12J7 in the main amplifier, and placing the series-connected pair in series with the power transformer centre-tap. Doing this will make no sensible difference to the main amplifier, except to reduce the H.T. voltage by 12 volts, while the complete lack of hum makes it well worth while to do.

Using the Harmonic Signal Generator for Receiver Alignment

In "Radio and Electronics" of December, 1953, we described a harmonic signal generator for aligning radio receivers, and we promised readers an article describing the best method of using it. Here is the promised article. It is not a long one, because the signal generator is very simple to use.

INTRODUCTION

For the benefit of those readers who may not have seen the original article in our December, 1953, issue, a brief description of the harmonic signal generator will be helpful. It consists of a stable oscillator which can be switched to work on either 100 kc/sec. or 1 mc/sec. This oscillator excites a harmonic amplifier, which is nothing more than a resistance-coupled high-gain pentode, provided with circuit values which cause its output to be rich in harmonics of the oscillator signal. Thus, when the 1 mc/sec. oscillator is working, the output of the device is a series of signals on 1, 2, 3, 4, etc., mc/sec., up to about 20 mc/sec. or more. These signals are exactly on the stated frequencies, provided only that the oscillator is exactly on 1 mc/sec. In order to ensure high accuracy, the Clapp high-stability oscillator circuit is used, and, although this does not employ a crystal, its stability, once initially adjusted, can be reckoned to be as good as that of a crystal.

When the 100 kc/sec. oscillator is working, the signals are harmonics of this freqeuncy, equally as accurate as before, and still extending to a quite high frequency. Unlike the conventional signal generator, the output of this device contains all these signals simultaneously, so that there is no need for any tuning dial. In order to use the series of signals for alignment purposes, it is only necessary to identify one of them. The signals actually form electrical marker signals, which will be received in turn as the tuning dial of the receiver is turned. How, then, does such a generator differ from the conventional one when one wishes it to align a receiver?

BROADCAST BAND ALIGNMENT

To illustrate the principles involved, let us first of all take the case of a broadcast receiver, or the broadcast band of an all-wave one. With the usual tunable signal generator, the procedure is to set the oscillator trimmer first of all, by setting the signal generator to 1,400 k/sec., setting the dial to that figure, and accurately tuning in the signal with the oscillator trimmer. With the harmonic generator, we can provide a signal at 1,400 kc/sec., by turning on the 100 kc/sec. oscillator, but the difficulty arises that at the same time we have signals on 1,200 and 1,300 kc/sec., which make it difficult to tell whether we are tuning in the right one or not. We proceed first of all to get over this in the following way. The 1,000 kc/sec. oscillator is turned on. Now, if the broadcast set is in alignment, this is the only signal that should be heard, because its second harmonic is outside the band.

The first step, therefore, is to set the dial of the receiver at 1,000 kc/sec., and to tune in the signal with the oscillator trimmer. This is merely a rough first adjustment. Next, the oscillator is switched to 100 kc/sec. The tenth harmonic, which is on 1,000 kc/sec., will then be received, without re-adjusting the receiver tuning. The dial is now turned towards the high-frequency end, and signals will be received at 1,100, 1,200, 1,300, and 1,400. We stop on the fourth one and tune it in accurately. By this means, we have identified the 1,400 kc/sec. signal. The chances are now that the signal is not received where the pointer says 1,400, so the next step is to move the oscillator trimmer slightly and re-tune with the main dial, keeping the process up until the signal is received on the right spot on the dial. This done, the aerial and R.F. trimmers can be adjusted for best signal and the preliminary alignment at the high end of the dial is completed. Count back to the 1,000 kc/sec. signal by tuning the receiver slowly back, and just as a check that nothing has slipped, turn the oscillator on to 1,000 kc/sec. again. If all is well, the signal will be there, but at this stage we cannot expect it to be at the right place on the dial.

[illegible] have to find the 600 kc/sec. signal in order [illegible] align the padder, so we turn on the 100 kc/sec. oscillator again, and tune the receiver towards the low-frequency end of the dial, counting the signals as we go. Having identified the 600 kc/sec. signal, we use it just as if it were the signal from an ordinary signal generator, to set the padder.

The padder is adjusted, a little at a time, while rocking the gang, until the combination is found which gives the greatest output signal. This should coincide with the dial-reading for 600 kc/sec. Having done this, we return to 1,400 kc/sec., and re-adjust the oscillator trimmer, since using the padder will have put the high end of the band out a little, and then make a final adjustment of the aerial and R.F. trimmers. Then we go back to 600 once more and make a final adjustment of the padder.

From the above description, it can be seen that the alignment procedure is exactly the same as that employed when a tunable signal generator is used. The only real difference is that in the case of the harmonic signal generator, the 1,400 and 600 kc/sec. signals have first to be identified from among their fellow-harmonics. This presents little difficulty, as it is merely a process of counting from the 1,000 kc/sec. signal, which is the only one present when the oscillator is working on this frequency.

ALIGNING SHORTWAVE BANDS

With the above description behind us, it is not difficult to see how the shortwave bands are aligned. For this purpose, the 100 kc/sec. series need not be used. For identification purposes, it will be necessary to use signals picked up by the receiver. Thus, the best plan for the shortwave bands is to adjust them roughly by ear, using the noise output of the set to peak up the trimmers other than the oscillator trim-

mer. This will align the set well enough to enable the strong overseas stations to be received. The best way of identifying the oscillator signals precisely is to first of all find the signals from the American standard frequency station WWV. This station transmits on 5, 10, and 15 mc/sec., and at the right time of day these are received here quite strongly. If WWV cannot be picked up, then it is possible to use the shortwave broadcast bands, which can be identified quite readily on a set which is in rough correspondence with the markings on its dial. For instance, the 30-metre band comes between 9 and 10 mc/sec., so that, once it is identified as such, we have automatically identified two of the harmonic signals—one on each side. From then on, we can proceed with the alignment in the ordinary way, since we know the frequencies of all the signals from the harmonic generator.

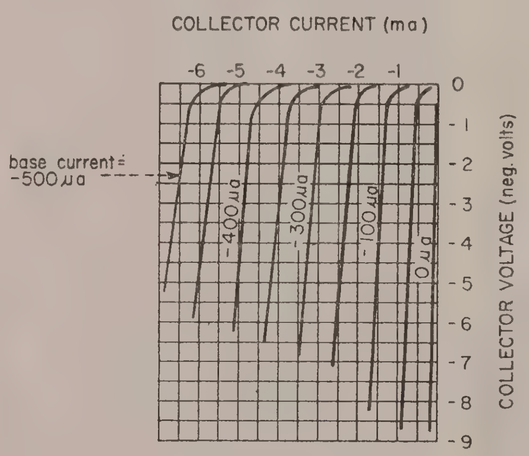
The harmonic signal generator was presented under the heading of "Test Equipment for the Amateur," and one of the things that were omitted from the design in the interests of simplicity was a further oscillator which would make identification of the harmonics on the shortwave band much quicker, and independent of signals off the air. If, for instance, we had, in addition to the existing oscillators, one working on the spot frequency of 5 mc/sec., we would be able to switch this on and get a series of signals at 5, 10, 15, etc., mc/sec. These would enable the individual members of the 1,000 kc/sec. series of signals to be identified, just as the 1,000 kc/sec. oscillator identifies the members of the 100 kc/sec. series when we are aligning the broadcast band. For professional use, the 5 mc/sec. oscillator would be a "must," but those of us who do not have to make a living out of lining up sets can afford to wait for the evenings, and then put in a bit of shortwave listening in order to identify the harmonics. The whole business actually sounds a good deal worse than it is in practice, and it is surprising how quickly one becomes acustomed to the small amount of extra work involved in using the harmonic generator as compared with the continuously tunable one.

(Continued on page 44.)

JUNCTION TRANSISTOR CIRCUITS

By the Engineering Department, Aerovox Corporation

The former tightness of the transistor situation has been eased favourably for the non-military experimenter and manufacturer by the present excellent availability of the new junction-type transistors.* The lower price of these components, compared with the almost prohibitive price of the earlier point-contact transistors, should stimulate private development of transistor circuits. It is expected that prices will drop further in proportion to the number of circuit applications which can be developed to utilize the wide spread in coefficients resulting in transistor manufacture.



TYPICAL COLLECTOR CHARACTERISTICS OF CK722 TRANSISTOR

FIGURE 1

The author has devoted several months to the checking of circuits employing the Type CK722 junction transistor, and now is in a position to present practical circuit data. The editors feel that this information will fill the prospective user's need for definite circuit constants, since much of the material previously published in electronic literature has contained only skeleton diagrams, leaving the reader confused as to actual values of components.

The circuits included here have been made to work satisfactorily and can be duplicated. It should be borne in mind, however, that these circuits satisfied one set of typical conditions and do not necessarily represent the best or only way of applying the transistor for the purpose intended. Considerable flexibility in individual design is possible. In addition, some readjustment of constants may be required when transistors of various manufacturers are used. The circuits described are intended specially for junction-type transistors, and some of them often will not operate equally well with point-contact triodes. In presenting this material, we feel that it will be invaluable in guiding the newcomer to transistor circuitry and will be of provocative importance as well.

*This refers to the U.S.A.—Ed.

FEATURES OF THE JUNCTION TRANSISTOR

Several characteristics of the junction transistor distinguish it from the point-contact type. One of the most important of these is the increased ruggedness of the junction type. In the junction transistor, the three conduction layers (P, N, and P in the case of the CK722) are parts of the same germanium wafer. There are accordingly no whiskers or sandwich sections which might be displaced accidentally.

A dramatic property of the junction transistor is its high efficiency and its ability to operate at very low

CK722 OPERATING DATA

ABSOLUTE MAXIMUM RATINGS

Collector Voltage (V_c)	—20 volts
Collector Current (I_c)	—5 ma.
Collector Dissipation	30 mw. at 30° C.
Emitter Current (I_e)	5 ma.
Ambient Temperature	50° C.

TYPICAL GROUNDED-EMITTER AMPLIFIER CHARACTERISTICS

Collector Voltage (V_c)	—1.5 volt
Collector Current (I_c)	—0.5 ma.
Base Current	—20 ua.
Current Amplification Factor (beta*)	12
Power Gain	1000 (30 db.) Source 1000 ohms; Load 20,000 ohms.

Noise Factor 22 db. at 1000 cycles

*This rating applies only to the grounded-emitter circuit. The current amplification factor *alpha* for the grounded-base connection is, of course, less than 1 for the junction transistor.

Figure 2

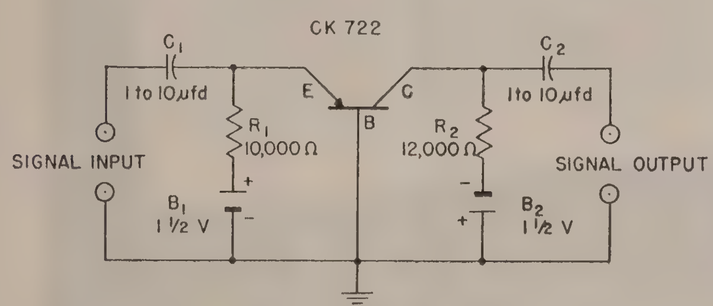
values of applied D.C. A class "A" amplifier using a junction type, for example, will operate close to the theoretical 50 per cent. efficiency point, as compared with a vacuum-tube amplifier giving 25 to 30 per cent. Practical amplifiers and oscillators can be operated from a single 1½-volt cell with current drains so low that in some arrangements the cell will give shelf life. Audio oscillators can be made to operate at such low D.C. levels that, in demonstrations, the "power supply" current has been furnished by a self-generating photocell, thermocouple, or makeshift wet cell made from two coins separated by a piece of paper moistened with saliva.

The temperature sensitivity of the junction transistor makes the latter somewhat poorer than the point-contact type, but the junction type is not as noisy. The maximum ambient temperature allowed for the CK722 is 50° C. The 1000-cycle noise factor is 22 db. (Compare the noise factor of 65 db. which is given for the CK716 point-contact transistor.)

Frequency response of the junction transistor appears to be lower than that of the point-contact type, and is limited by such factors as the increased capacitance of the junction layers and the differences in mobility of the carriers. Our tests indicate that the CK722 is suited particularly to audio and low-fre-

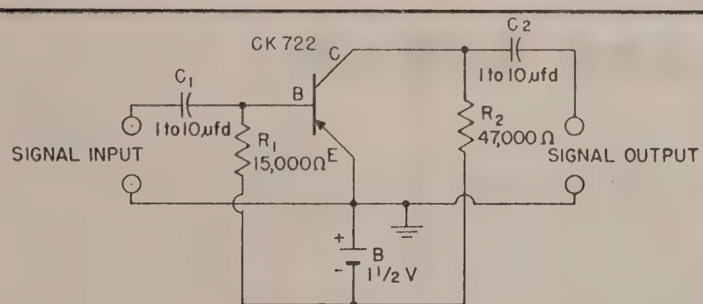
quency R.F. applications, of which there are many in each category. As a radio-frequency oscillator, this unit has given good performance in our circuit as high as the upper limit of the standard broadcast band, but beyond that point its operation has not been encouraging.

Figure 1 shows a family of collector current-vs-collector voltage curves for the CK722. These curves are plotted for eight values of constant base current (0, 50, 100, 200, 300, 350, 400, 450, and 500 micro-amperes). Note that these curves have the general appearance of pentode vacuum-tube curves. The collector voltage (V_c) values are negative. The corresponding collector current (I_c) also are designated as negative.



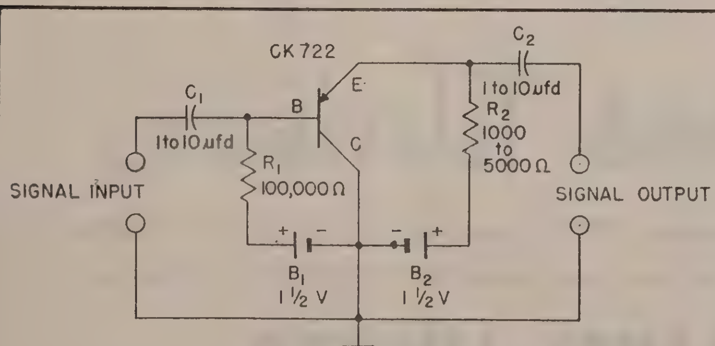
SINGLE-STAGE GROUNDED-BASE AMPLIFIER

FIGURE 3



SINGLE-STAGE GROUNDED-EMITTER AMPLIFIER

FIGURE 4



SINGLE-STAGE GROUNDED-COLLECTOR AMPLIFIER

FIGURE 5

The table in Fig. 2 lists important operating data for the CK722. One listing is apt to confuse the reader who has had some prior contact with transistor literature. This is the current amplification factor, always mentioned as less than unity for junction resistors, which is given here as 12. The reason for this higher figure is that the factor given in Fig. 2 is not alpha (which is less than 1), but beta, which applies only to the grounded-emitter (base-input) operation shown. Beta (b) is related to alpha (a) as follows: $b = 1/(1-a)$.

JUNCTION TRIODE CIRCUITS

Figures 3 to 9 show several selected amplifier and oscillator circuits. These can serve as building blocks for more complex equipment. Note that each of these arrangements uses the low D.C. voltages at which the junction transistor is capable of operating.

Single Amplifier Stages.—Figure 3 is a resistance-coupled, grounded-base audio amplifier circuit. The grounded-base arrangement is the progenitor of all transistor circuits.

The grounded-base circuit has an input impedance of 5,000 to 10,000 ohms, depending upon individual transistor collector characteristics. Higher operating impedances are possible in the output with higher R_2 values, but with somewhat reduced gain. Operating into a high-impedance load (100,000 ohms or higher), this stage, as shown, has a voltage gain of 40, although the gain may vary between 36 and 44 with individual transistors. At lower load resistance values, the gain drops proportionately.

With 1 μf. input and output capacitors (C_1 and C_2), the frequency response is such that the gain at 100 cycles is 25 per cent. of the 1000-cycle value, and at 20,000 cycles is 92 per cent. of the 1000-cycle value. With 10 μf. capacitors, the 20-cycle gain is 67 per cent. of the 1000-cycle value, and the 20,000-cycle gain 98 per cent. of the 1000-cycle value. Miniature, low-voltage electrolytic coupling capacitors may be used for the high values.

Because the grounded-base amplifier requires two batteries, there is some objection to its use. Current drain of the emitter battery is 150 microamperes, and of the collector battery 100 μa.. The grounded-base amplifier offers the maximum power gain possible with a given transistor.

Figure 4 shows a grounded-emitter amplifier. An important advantage of this circuit is its ability to operate with a single battery at a drain of 10 to 80 microamperes, depending upon the individual transistor employed. Input impedance is of the order of 1000 ohms; output impedance 20,000 to 40,000 ohms. Higher output impedance values are possible with higher values of R_2, but with reduced gain.

With the constants given in Fig. 4, voltage gain of this stage is 40 to 50 when B is 3 volts. These gains are obtained only when the stage is worked into a high load impedance (100,000 ohms or higher).

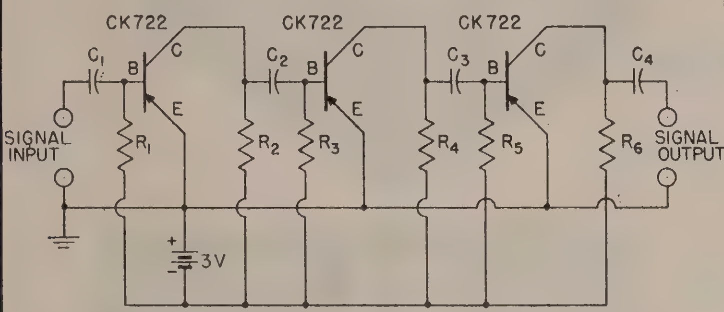
Frequency response is the same as that quoted for the grounded-base amplifier in the foregoing paragraphs.

Figure 5 shows a grounded-collector amplifier. This circuit has high input impedance (of the order of 50,000 ohms) and low output impedance (1000 ohms). It thus is equivalent to the cathode-follower vacuum-tube amplifier. Like the cathode-follower, the

grounded-collector circuit provides no voltage gain ("gain" of the stage shown in Fig. 5 is 0.2 to 0.3). It does afford power gain, however, of the order of 15. The frequency response of this stage is the same as that stated earlier for the grounded-base circuit.

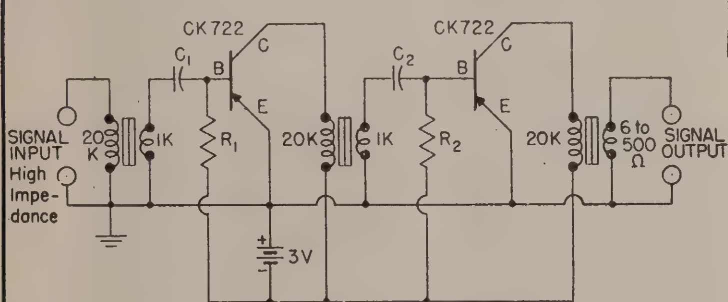
A slight disadvantage of the grounded-collector type of circuit is its requirement of two batteries (B_1 and B_2). But its relatively high input impedance suits it very well to use as the input stage of a transistor amplifier whenever the loss in voltage gain is of no consequence.

We did not discover that bypassing either of the power supplies in any of the circuits shown offered improvement in performance at any frequency between 20 cycles and 20 kc.



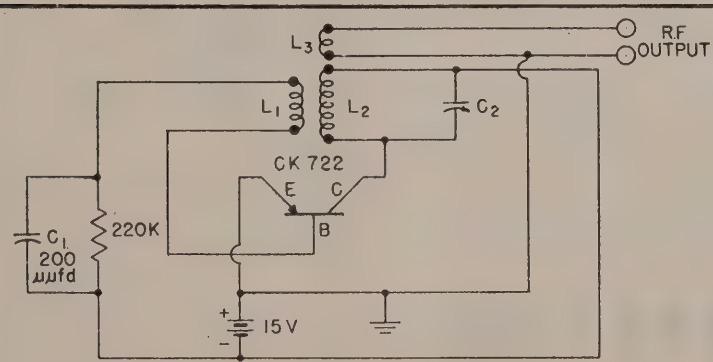
3-STAGE RESISTANCE-COUPLED, GROUNDED-EMITTER AMPLIFIER

FIGURE 6



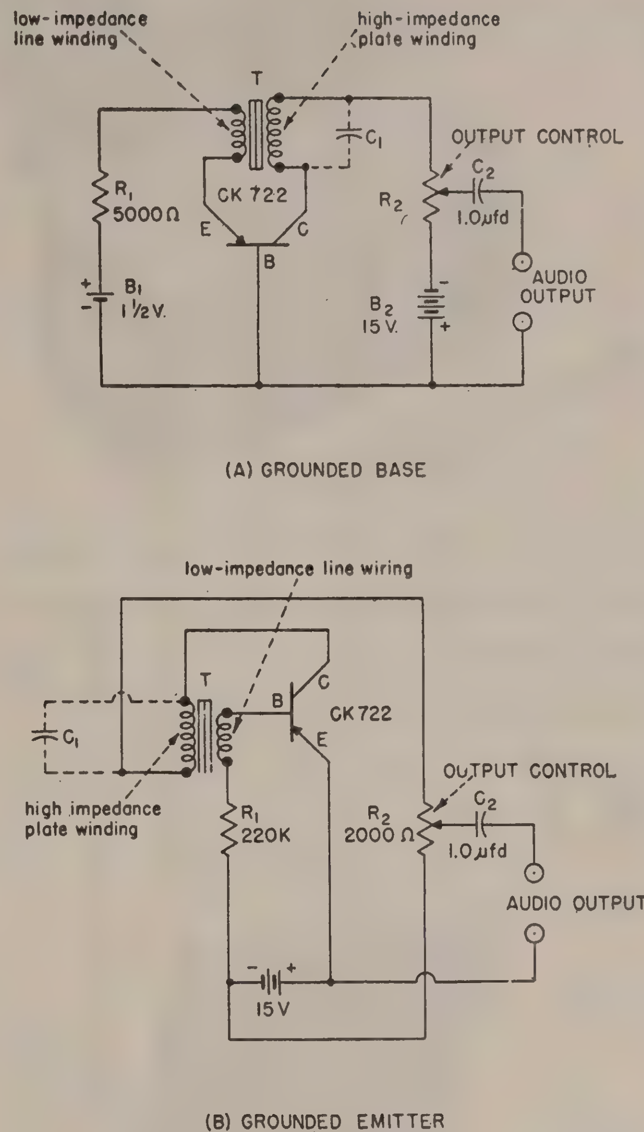
2-STAGE TRANSFORMER-COUPLED, GROUNDED-EMITTER AMPLIFIER

FIGURE 7



GROUNDED-EMITTER TRANSISTOR R.F. OSCILLATOR

FIGURE 9



TRANSISTOR AUDIO OSCILLATORS

FIGURE 8

CASCADED AMPLIFIERS

The circuits given in Figs. 3 to 5 are fundamental building blocks. Like tube circuits, transistor amplifier stages may be cascaded for increased voltage gain and power gain. The difference with transistors, however, rests in the fact that in grounded-base and grounded-emitter stages, the output impedance is higher than the input impedance. This requires an impedance stepdown between stages. While resistance coupling may be employed as well as transformer coupling between stages, the greater power gain will be obtained with interstage transformer coupling, since the latter has the lower step-down ratio and offers best power transfer. In resistance coupling, at least one additional transistor stage usually is necessary to provide the same overall power gain afforded by transformer coupling.

Figure 6 shows one method of resistance-coupling three junction transistor stages. Overall power gain

Model L/2

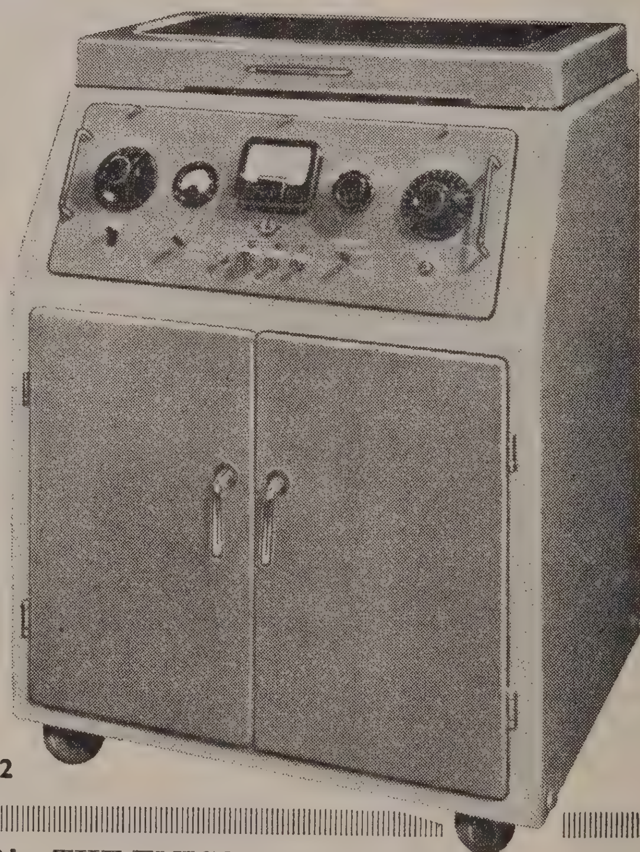
Model TR/50

E.M.I. Tape Recorders for professional use.

Model BTR/2—the high fidelity studio recorder.

Model TR/50—a Mains/Portable recorder available in two versions with tape speeds of either 15″ and 7½″ or 7½″ and 3¾″ per second.

Model L/2—a battery operated recorder completely self-contained which is ideal for 'on the spot' recordings.



Model BTR/2

Model 2301

Model 2301—THE EMICORDA—designed for the public, this set combines quality of recording and reproduction with simplicity of operation which is so important for the non-professional user.

ES25

E.M.I. SUPPLIERS

(Trade Division of H.M.V. (N.Z) Ltd.)

P.O. Box 296 162-172 WAKEFIELD STREET, WELLINGTON Phone 54-890

is approximately 60 db. Collector resistors R_2, R_4, and R_6 each is 20,000 ohms. Base resistors R_1 R_3 and R_5 each is 150,000 ohms. For best results, each of these resistors should be adjusted carefully for the best gain and lowest noise output with the individual transistors used. Capacitors C_1, C_2, C_3, and C_4 each is 10 μf. This amplifier will deliver approximately $2\frac{1}{2}$ milliwatts output to a high-impedance load. A 1000- or 2000-ohm headphone may be connected in place of R_6 and C_4 to obtain approximately the same output in such applications as hearing aids, pocket radio receivers, etc.

Figure 7 shows a transformer-coupled 2-stage transistor amplifier. This unit has an overall power gain of approximately 50 db. The interstage transformers have primary impedances of 20,000 ohms each, and secondary impedances of 1000 ohms each. For experimental setups, good results can be obtained with carbon-microphone transformers connected backward. The output transformer has a 20,000-ohm primary. Its secondary may have the proper value required to match a small loudspeaker, headphones, line, or other device. If desired, a 1000- or 2000-ohm headphone may be connected in place of the primary of the output transformer, T_3. Suitable subminiature transformers for use in the transistor amplifier intended for hearing aids, pocket receivers, are available at most distributors. A high-impedance crystal microphone may be coupled into the first transistor by using a 200,000- to 1000-ohm input transformer at T_1.

In Fig. 7, capacitors C_1 and C_2 each is 10 μf. Resistors R_1 and R_3 each is 150,000 ohms.

Using the fundamental building blocks, a number of combinations of cascaded amplifier stages is possible to suit individual requirements. For example: grounded-base, grounded-emitter, grounded-collector, resistance-coupled, and transformer-coupled stages may be combined, as needed.

TRANSISTOR OSCILLATOR CIRCUITS

The CK722 junction transistor appears to oscillate most readily in an inductive-feedback type of circuit. Figure 8 shows two audio-frequency oscillators employing this principle. Figure 9 is a radio frequency oscillator employing inductive ("tickler") feedback.

Audio transformers are used in Fig. 8 (A) and 8 (B). In each instance, the high-impedance winding is connected to the collector. A satisfactory transformer is the type used to couple a single triode plate to 500- or 600-ohm line. Satsfactory results may be obtained also with a carbon-microphone transformer. The transformer must be phased properly for oscillation. If oscillation is not obtained immediately upon application of battery voltage, reverse the connections of either the primary or secondary. With a microphone transformer at T in each circuit, a 700-cycle signal was generated. The "natural" frequency will depend upon the inductance of the windings and their distributed capacitance, and may be lowered by means of capacitors connected at C_1.

Figure 8 (A) shows a grounded-base oscillator; Fig. 8 (B) a grounded-emitter oscillator circuit. The first circuit requires two batteries, but is somewhat less temperature-sensitive than the second.

Air-wound coils are used in the radio-frequency oscillator, Fig. 9. The top frequency at which this circuit has been operated with the CK722 is 1500 kc. No frequency data are published on this transistor.

Tight coupling is employed between coils L_1 and L_2, the former being wound on top of the latter. The output coupling coil, L_3, is wound on the same form close to L_2. By making these coil sets plug-in, frequency bands between 50 and 1500 kc. may be covered.

A good broadcast-band oscillator may be made with L_2 a 540-1750 kc. antenna coil. L_3 is the slip-on primary normally supplied with the antenna coil. L_1 consists of 75 turns of No. 30 enamelled wire closewound on top of the manufactured coil L_2. Coil I_1 is insulated from L_2 with scotch tape. C_2 is a 365 $\mu\mu$f. tuning capacitor.

An interesting regenerative broadcast receiver having good sensitivity can be made by connecting antenna and ground to the two terminals of L_3, and a pair of 2000-ohm (or higher, magnetic) headphones in series with the collector and L_2. Regeneration can be controlled by means of a 1-megohm potentiometer substituted for the 220-000-ohm fixed resistor shown in Fig. 9. A transistor audio amplifier may be added by substituting the amplifier input transformer for the headphones. Near the vicinity of strong local stations, an outside antenna and ground are not required, an A.C.-D.C. antenna bank, connected to one terminal of L_3 being sufficient. The other terminal of L_3 then would be conected to positive terminal of the battery as shown in Fig. 9.

The PHILIPS Experimenter

An advertisement of Philips Electrical Industries of N.Z., Ltd.

No. 77: Philips Negative-Temperature-Coefficient Resistors (Part 2)

Reprints of these EXPERIMENTER articles, complete with illustrations, will be mailed to any address for one year for a subscription of 5s. Application should be made to Technical Publications Department, Philips Electrical Industries of New Zealand Ltd., P.O. Box 2097, Wellington.

TYPES AND SIZES OF NTC RESISTORS

NTC resistors are made in a number of different types, to suit a wide variety of applications. They are made in sizes so small that the glass-covered resistor may be inserted in a vein for measuring intravenous blood temperatures, and large enough to dissipate four to five watts of electrical energy, and it is partly owing to the wide variety of physical forms in which the resistors are made that gives them their extraordinary versatility. The commonest types are those made as small rods, with leads soldered on to the ends, and very similar in appearance to conventional resistors of ½-watt and larger sizes. Since their resistance varies so markedly with temperature, NTC resistors are specified as to value by quoting their resistance at a temperature of 20° Centigrade. Their resistance at any other temperature can then be found approximately by referring to published curves, some of which will be found reproduced here. So that this article may form a useful reference to those who may wish to use the resistors, the types are outlined below, and their essential characteristics given.

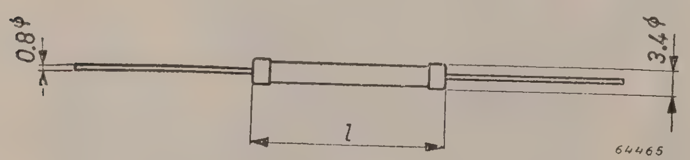


Fig. 1.

Types 83910 and 83911

Type 83910 resistors are made in three values—viz., 2k., 4k., and 7k. These values refer to the resistance at 20°C., which is written R_{20} for ease of reference. Thus, a particular resistor is specified as type 83910/2k., meaning that it is an 83910 resistor, with a value of R_{20} of 2000 ohms.

Type 83911 resistors are also made in only three values of R_{20}—namely, 17.5k., 35k., and 80k., and they are individually specified in the same way as before. For instance, a resistor 83911/17k5 is a type 83911, with an R_{20} of 17.5k. ohms. Their dimensions, referred to Fig. 1, are as follows.

For types /2k and /17k5, dimension 1 = 15mm.

For types /4k and /35k, dimension 1 = 29mm.

For types /7k and /80k, dimension 1 = 47mm.

Other dimensions on the diagram are also in millimetres.

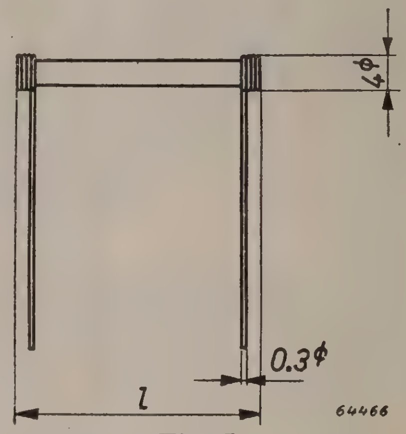


Fig. 5.

The most important characteristic of the resistors is the way in which their resistance changes with variation of voltage across them, current through them, or power dissipated in them. For types 83910 and 83911, this information is summarized in Figs. 2 and 3. These curves, of which one is drawn for each type of the six already mentioned, show the current flowing for given voltages across the resistors. Since both scales are logarithmic, it is possible to draw diagonal lines representing power dissipated, and another set representing the resistance. On the curves, too, are marked the temperatures attained by the resistor. At the left of the graph, it will be seen that the curves are parallel with the lines representing constant resistance. Indeed, the behaviour of a normal resistor, whose value does not change with current through it, would be indicated on the graph by a straight line coinciding with or parallel to the diagonal lines marked with resistance values. In Fig. 2, for example, the upper curve, representing a 7k. resistor, shows that at currents up to about 3 ma., it behaves just as a normal resistor would do. This is merely another way of stating that the heat developed in the resistor at such low currents is not able to raise the temperature sufficiently to bring the great lowering of resistance into play. At approximately 4.7 ma., however, the temperature has risen to 30° C., and the resistance has dropped to nearly 5000 ohms. As the current increases further, the resistor heats up more rapidly, and the resistance drops very rapidly, as is shown by the curve cutting the lines of constant resistance at an increasingly steep angle. At a current of 70 ma., the temperature has risen to 150° C., and the resistance has dropped to 500 ohms.

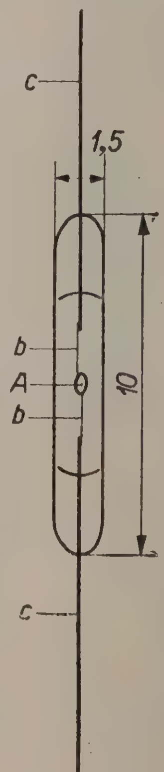


Fig. 8.

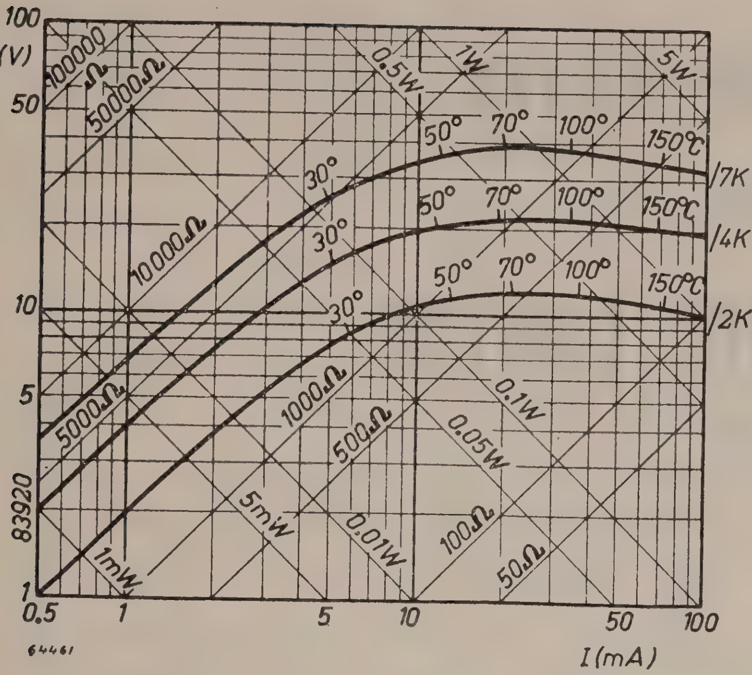


Fig. 2.

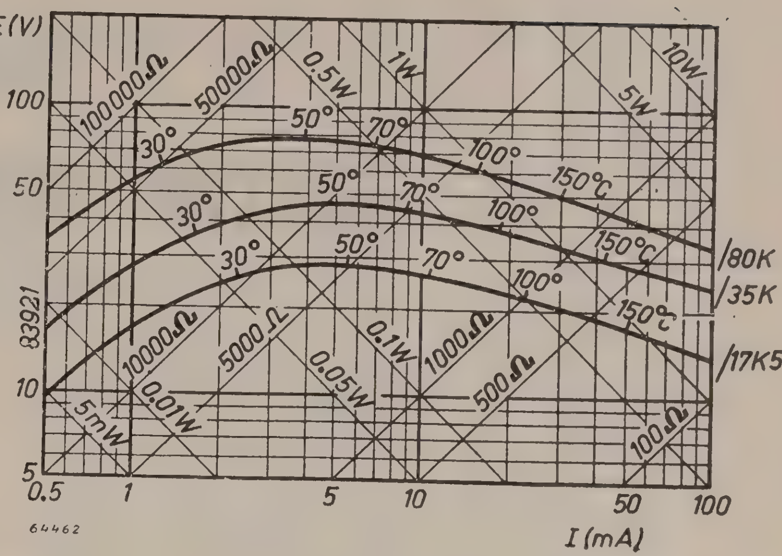


Fig. 3.

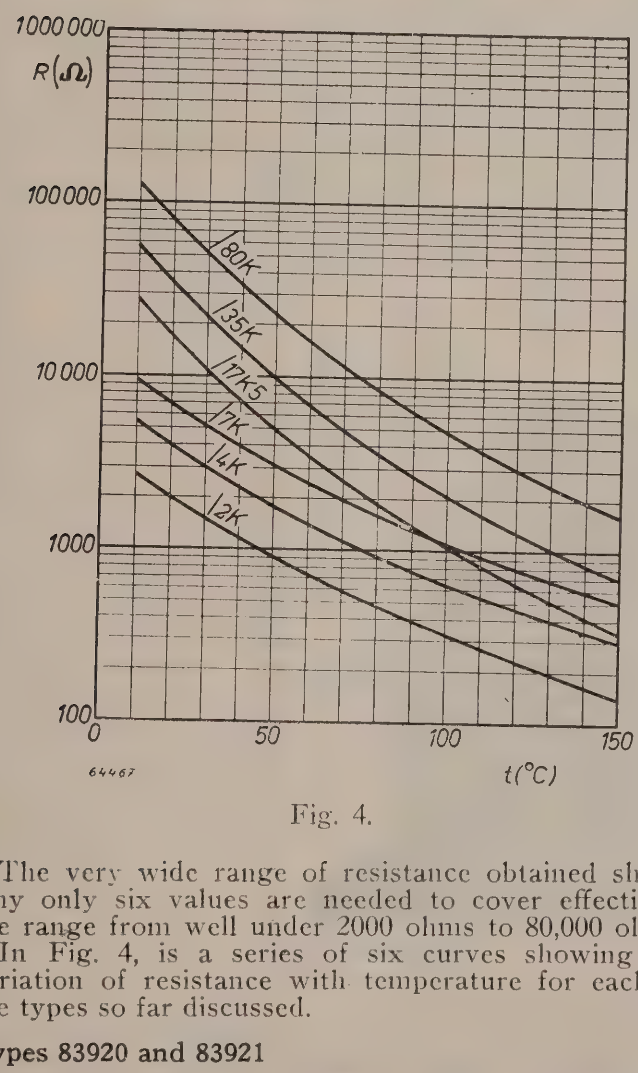


Fig. 4.

The very wide range of resistance obtained shows why only six values are needed to cover effectively the range from well under 2000 ohms to 80,000 ohms.

In Fig. 4, is a series of six curves showing the variation of resistance with temperature for each of the types so far discussed.

Types 83920 and 83921

These are also rod resistors, slightly larger physically than the previous types, and capable of dissipating up to approximately 2 watts. These types are particularly stable in their characteristics, and are recommended for measuring applications of all kinds. Their form is shown in Fig. 5. Like the previous ones, they are made in six sizes only, with the same values of R_{20}. However, they are available in two tolerances, 20% and 10%. The tolerance is indicated in the type number by adding A after the main number to mean 10%, and P to mean 20%. This, a resistor 83910A/4k. is an 83920 resistor, with R_{20} equal to 4000 ohms, and a tolerance of 10% on the value of R_{20}.

The load characteristics for these types are given in Figs. 6 and 7.

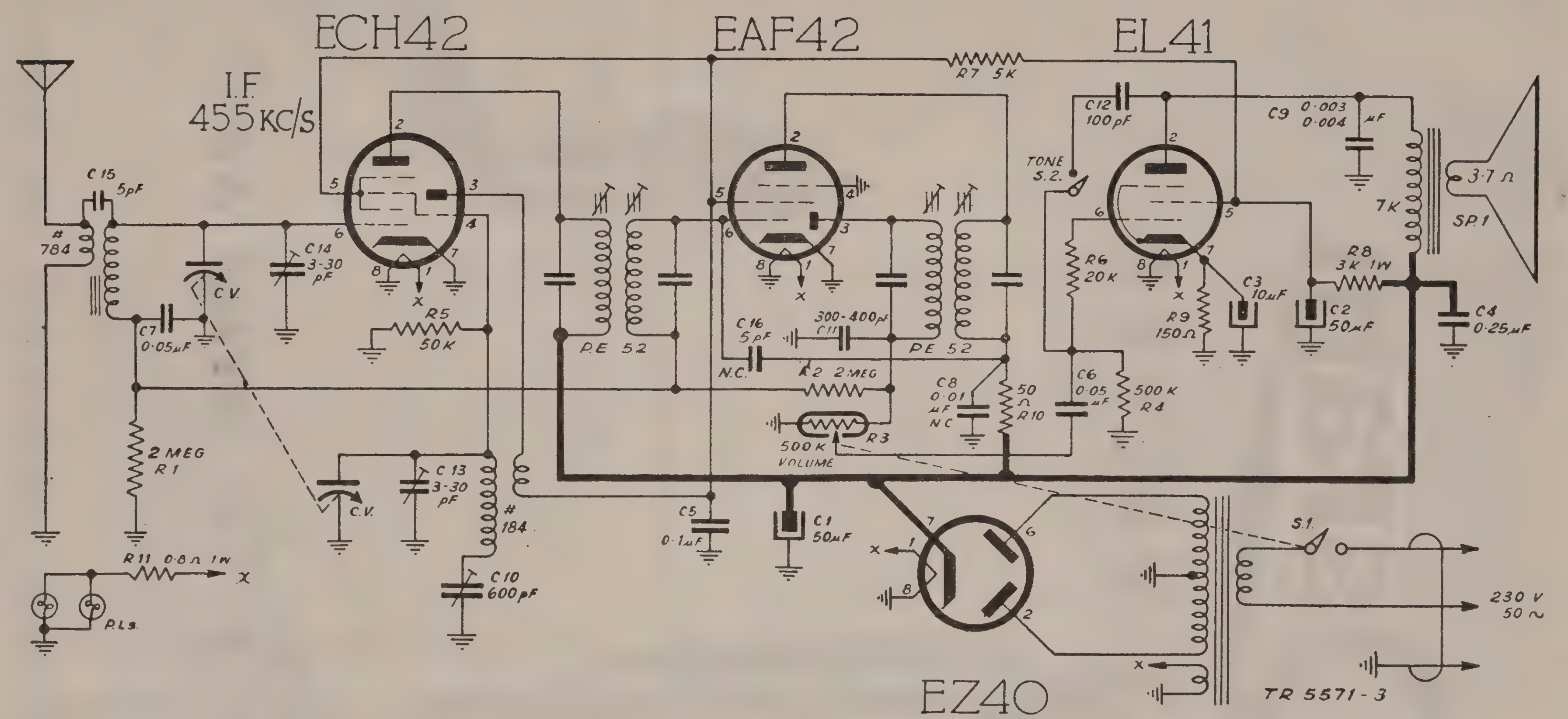
Miniature NTC Resistors

In Fig. 8 is a diagram showing the construction of the miniature glass-sealed NTC resistors, much enlarged. The resistor material is in the bead A, inside a gas-filled tube. The dimensions in millimetres show how minute these resistors are. Since they are sealed from external influences, the characteristics of this type are particularly stable, and they are eminently suitable for measuring purposes, and particularly so for measuring amounts of R.F. energy at ultra-high and micro-wave frequencies. On account of their small size, too, they are particularly sensitive to rapidly changing temperatures, which makes them suitable for incorporating in oscillators, amplifiers, etc., as automatic gain controlling elements. They are made in two type numbers, 83900 and 83901. The former embraces values of R_{20} between 1000 and 3500 ohms, and the latter from 100k. to 350k. They can be had in any value of R_{20} between these limits, with a tolerance of 20%. In Figs. 9 and 10 are shown the load characteristics of the two types. From these, it can be seen that they respond to very small powers indeed. The maximum power dissipation is approximately 40 milliwatts.

As well as the standard mounting illustrated in Fig. 8, it is possible to obtain these types in other forms, to special order. They may be had in small evacuated tubes, and in long glass tubes, drawn out to a point at one end, with the active resistor material right at the tip of the finely drawn end portion.

(Continued on page 31.)

For the Serviceman: CROMWELL MODEL 4153



SCHEMATIC DIAGRAM MODEL 4153.

VOLTAGE READINGS

Use	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
Conv.	ECH42	6.3 a.c.	163	76	−10	76	0	—	—
I.F.-Det	EAF42	6.3 a.c.	163	0	—	76	0	—	—
Output	EL41	6.3 a.c.	155	—	—	128	0	3.2	—
Rect.	EZ40	6.3 a.c.	168 a.c.	—	—	—	168 ac	163	—

RESISTANCE READINGS

Use	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
Conv.	ECH42	—	500K	508K	50K	508K	1 meg	—	—
I.F.-Det	EAF42	—	500K	560K	—	508K	1 meg	—	—
Output	EL41	—	500K	—	—	503K	520K	150	—
Rect.	EZ40	—	475	—	—	—	475	500K	—

1. D.C. voltage measurements are at 2.000 ohms per volt—A.C. voltage measurements at 1,000 ohms per volt.
2. Socket connections are shown as bottom views.
3. Measured values are from socket pin to common negative.
4. Nominal tolerance on component values make possible a variation of ± 10% in voltage and resistance readings.
5. Volume control at maximum, no signal applied for voltage measurements.
6. Resistance readings in B+ circuits may vary widely according to the condition of filter capacitors.

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Philips Experimenter

(Continued from page 25.)

Miniature NTC Resistors with Heating Coil

A further variation which can be exceedingly useful is the miniature N.T.C. resistor with a separate heating coil. This type allows the current in one circuit to control that in another, entirely separate from it electrically. The type numbers are 83905 and 83906. They correspond exactly to types 83900 and 83901, except for the addition of the heating coil, which in all cases has a resistance of approximately 100 ohms. An advantage of heater control is that current in a low-impedance circuit can be made to control that in a high-impedance circuit—a feat that cannot be accomplished at all by a conventional NTC resistor.

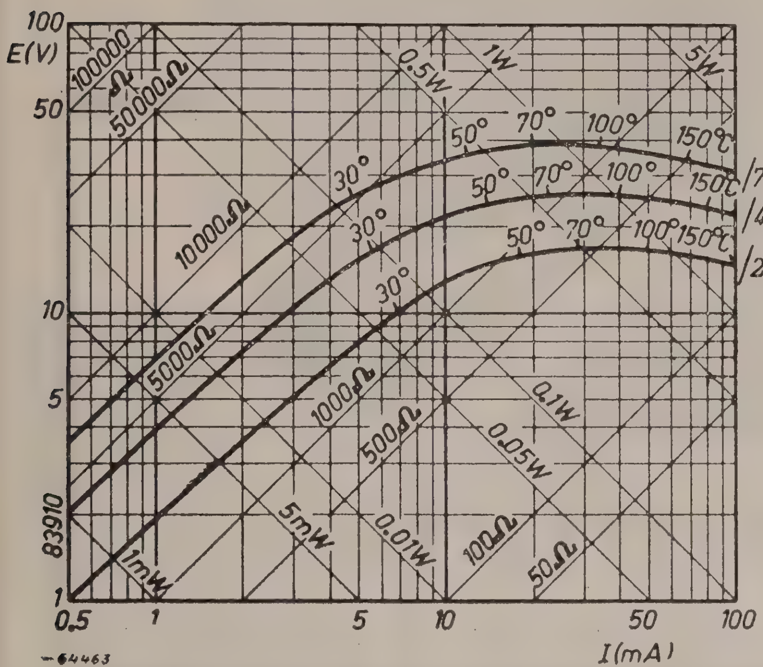


Fig. 6.

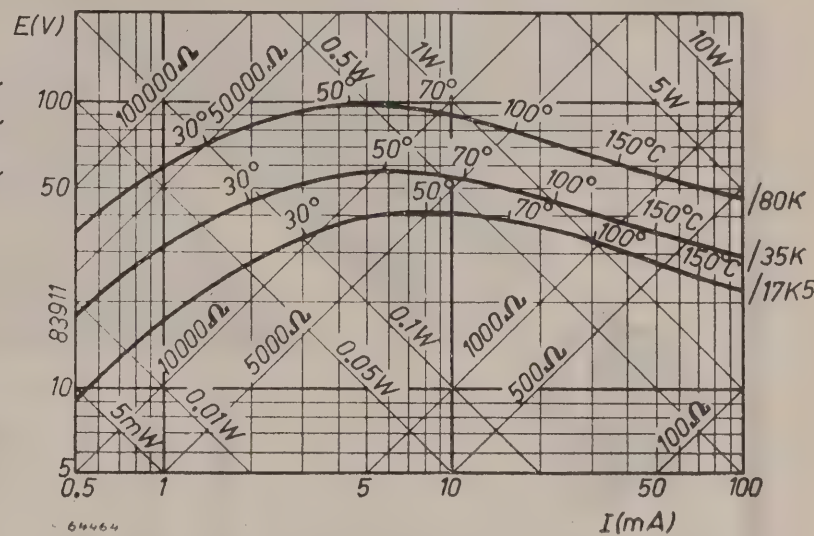
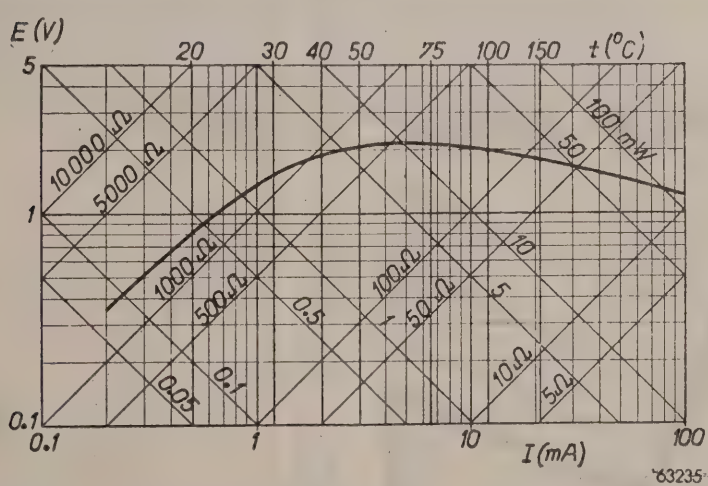


Fig. 7.



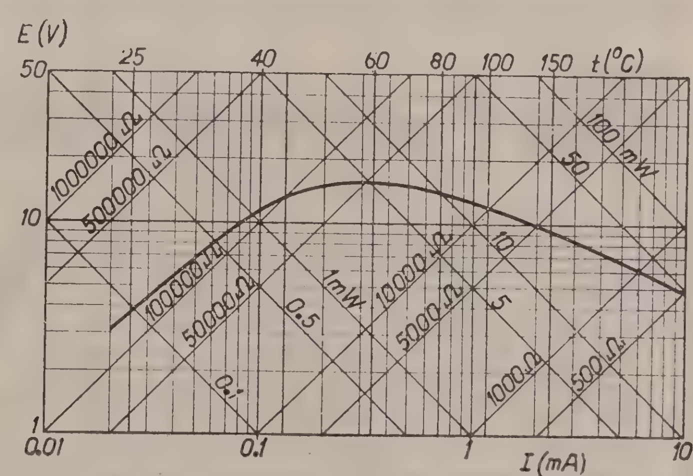


Fig. 9 (left) and Fig. 10 (right).—Curves for miniature NTC resistors, types 83900 and 83901 respectively.

TRADE WINDS

Television at the Wellington Industrial Fair

Television, with a capital T, literally stole the Show when Messrs. Pye (New Zealand) Ltd., and H.M.V. (N.Z.) Ltd. both gave excellent public demonstrations of the capabilities of modern television at the recent Wellington Industrial Fair. Technically, the Pye demonstrations were on a lavish scale, thus enabling them to furnish programmes of definite public appeal, produced in much the same manner as those in a modern TV broadcast station.

Three camera chains and full control facilities, supported by a low-powered transmitter, really showed Wellington what TV could do.

A section of the crowd watching operators manipulate the TV cameras inside the glass-walled studio which was part of the Pye stand.

Highlight of all was the telecast of the civic reception to Her Majesty the Queen. Receivers installed in the Wellington Public Hospital enabled patients to see not only this, but all programmes broadcast from the Winter Show buildings, and made a great difference to hospital life.

A representative of this journal was privileged to inspect the equipment in detail and to watch the production of an afternoon programme, seeing the producer and the control operators at work. In an amount of studio space which could only be described as microscopic, the ease with which the equipment enabled the crew to cope with the complicated programme was most impressive. Indeed, the writer was strongly reminded of the alarms and excursions which took place in pre-war broadcasting studios. In spite of the addition of vision, the atmosphere was very similar, and it seems that the sleight-of-hand required by one is not so very different from that needed by the other. Most impressive of all was the picture quality produced by the image-orthicon cameras. Not only was the definition excellent, but the gradation and detail in high-lights and shadows was quite remarkable. However, it was interesting to note that the two cameras in use at the time had markedly different characteristics. Though no public complaints were heard of a fault in either of them, one was afflicted by a fairly heavy white-after-black effect, which was absent on the other. Possibly this was simply a matter of adjustment, but it did underline the necessity for very particular care in matching the characteristics of camera tubes and associated equipment—something which one would not expect to notice in the ordinary course of events.

Viewed by so many people, these demonstrations have created considerable public interest in TV as a new form of home entertainment. The temporary importation of some £35,000 worth of equipment, key operating personnel from Britain, and the training of local recruits as camera operators are no mean feats. Our congratulations go to the Pye organization, whose effort and enterprise must have its effect on the battle for the establishment of TV in this country.

* * *

The H.M.V. stand drew its share of interested spectators with another very effective TV demonstration. Here, the emphasis was on industrial television, showing an E.M.I. unit comprising a miniature camera using a new miniature C.P.S. Emitron tube, and a small wall-mounted unit containing the synchronizing generator and other essential circuits. With the camera trained on the spectators outside the stand, the picture was displayed on several receivers in full view of the same audience. Crowd reactions on seeing itself televized were extremely amusing, and many of the "unrehearsed" programmes provided by the audience were most entertaining and greatly appreciated by everyone.

"BREAK-IN" HAS A NEW LOOK

The January 1954 issue of our contemporary presents a completely "new look", wtih its increased page size, snappy headings and pithy paragraphs on technical matters of interest to amateur transmitters. We could not help noticing that several of these were credited to a well-known radio firm, whereas in fact the circuits first made their appearance in amateur equipment designed and described in *Radio and Electronics* several years ago!

H.R.H. THE DUKE OF EDINBURGH ADDRESSES SCIENTISTS

Many readers of this journal will have heard with interest the speech given in Wellington by His Royal Highness the Duke of Edinburgh to representatives of scientific bodies throughout the Dominion. It is not possible here to do more than make brief comment on the Duke's address, which had an importance quite out of proportion to the numbers of people who were privileged to be present. Luckily, the speech was broadcast, and thus was heard by the whole country. While the Duke is not a trained scientist, his remarks showed him to be particularly well informed, both as to the role of science in the world as a whole, and also on the particular needs of this country's development. It was especially pleasing to note that he was aware of the deadening influence on scientific research of excessive operational control by those who control the purse-strings. In our case, the reference automatically applies mainly to the Government which does supply most of the money needed by research organisations, and which has as a Government organisation the Department of Scientific and Industrial Research. It was clear, too, that the Duke's audience fully concurred with his ideas on this subject, if one particular round of applause was any criterion!

It is certainly something new for Royalty to take such an active interest in matters scientific as does the Duke of Edinburgh, and those of us who are convinced of the importance of the role of science, properly applied, in the future of the Empire, can take heart from the thought that the Duke's not inconsiderable influence is directed along lines that are closely allied to our own efforts to see that science takes its rightful place in the modern scheme of things.

CHANGE OF ADDRESS

When you change your address, be sure to notify the Subscription Department, "Radio and Electronics," P.O. Box 8022, Wellington, New Zealand, and do this at least four weeks in advance. To avoid disappointment through not receiving your copy of "Radio and Electronics," should it go to the wrong address through your failure to notify us of a change, we earnestly ask for your co-operation in this important matter.

DECCA "MEDIUM PLAY" RECORDS

Recently, the Decca Record Co. Ltd. introduced a "medium play" fine-groove record to supplement its series of long-playing records. This is a 10 in. disc playing at $33\frac{1}{3}$ r.p.m. Each record contains complete on each side a medium-length piece of music, thus avoiding any break for turnover.

The "medium play" record can be played with the same pick-up head as the L.P., is made of the same flexible material, and is recorded by Decca's FFRR system. On an average, each side is stated to give approximately nine minutes' playing time.

There are 25 numbers in the first release, and each record is packed in an art sleeve with descriptive notes on the reverse side.

* * *

NEW X-RAY DEVICE

The Westinghouse Electric Corporation advises the perfection of an "X-ray telescope" capable of giving an image 200 times brighter than any previous X-ray equipment. This is now being adopted as a major aid to diagnosis in X-ray laboratories, hospitals, and doctors' offices.

It is reported to magnify a "living image" of the patient's organs 200 times, and radiologists describe it as the greatest advance since the development of the X-ray tube.

PIONEER OF SHORT-WAVE BROADCASTING DIES

Alfred Weedon Hall, who died on 22nd May, 1953, at the age of 60, was one of the band of engineers who assisted Mr. C. S. Franklin in developing the Marconi short-wave beam system for world-wide radio communication in the 1920s. He was trained as an electrical engineer, and after two years' work in the power field, he joined the Marconi company as a test room assistant in January 1913. In 1917 he was given a commission as Sub-Lieut. R.N.V.R. and assigned to naval duties in Canada.

After demobilization in 1919 he joined the staff of Mr. C. S. Franklin working on the spaced frame system of reception at Letterfrack and Towyn. In 1921 he was put in charge of the Birmingham end of the experimental duplex radio telephone link between Birmingham and Hendon, which operated on 15 metres with directional aerials. Thus began his association with short-wave communication which was to last for over 20 years. When interest shifted to the development of long-distance communication on short-waves in 1922 he assisted Mr. Franklin on the short-wave transmissions from Poldhu to the Marchese Marconi on the *Elettra*. This involved the development of a high-power (10 kW) transmitter for waves below 100 metres with good

(Concluded on page 44.)

A SHORT HISTORY OF TELEVISION

(Contributed by Philco Division of Russell Import Co., Ltd.)

While you will be aware of the many arguments which can be advanced to show that television is merely complementary to radio, a more important fact still, is that overseas reports clearly indicate that the statement we make is indeed a fact. If the correct approach to the subject is provided, the exact date when television will operate becomes a matter of minor importance.

As early as 1935 the General Manager of the New Zealand Broadcasting Board, Mr. E. C. Hands, indicated that, in his opinion, television was five years away. This report, incidentally, was printed in the *Dominion* under date 15th August. It is, therefore, obvious that the question of forecasting a date for the commencement of television is, to say the least of it, a little hazardous. As the purpose of this article is to tell of the development of television and its effect, on the radio industry, perhaps a short historical outline would not go amiss.

GENERAL HISTORY OF TELEVISION—BRITAIN

Many people think television is an entirely new invention, being in fact, a further development of radio. Television history, however, dates back as far as 1873 when the light sensitive properties of selenium were discovered. The principle of the scanning disc which was used in early B.B.C. television transmissions was established as far back as 1884 in Germany. This will show that the development and perfection of television transmission has been proceeding over a very long period. The first demonstration of what is generally accepted as real television was given during January, 1926, in London by John Logie Baird. Baird had already given a public demonstration in April, 1925, showing the transmissions of simple silhouettes, but the second demonstration included moving figures and was greeted with enthusiasm by the technical and lay press both in England and America. In February, 1928, Baird transmitted a picture across the Atlantic and by the end of that year Baird had successfully demonstrated daylight television; infra-red television, stereoscopic and even colour television.

In 1929 the British Broadcasting Corporation granted facilities to the Baird Corporation to use Station 2LO for the transmission of visual signals. In 1932 a studio was equipped in Broadcasting House and in the same year the Derby was televised and viewed on a 10 ft. x 8 ft. screen in the Metropole Cinema, London. The system used up to this time had been mechanical, using what is known as the Nipkow disc or Weiller mirror drum. The 30-line pictures being transmitted at the rate of $12\frac{1}{2}$ pictures per second gave poor definition. In 1934 a special committee recommended that a high definition service should be started as soon as possible. Experimental equipment was installed and operated from Alexandra Palace, the apex of the special omni-directional aerial being 600 ft. above sea-level.

After a period of experimenting the station was formally opened, and in 1936 it became the first public television service in the world. The standard of 405 lines, 25 pictures interlaced scanning with positive modulation of the carrier was adopted in February, 1937. For two years unsurpassed service was given with pictorial and programme quality being continually improved. During the first half of 1939, 20,000 viewers registered, and an extensive campaign was run boosting television. The campaign, however, could not achieve the desired results because the war intervened. On September 1st, 1939, following a programme from the Radio Exhibition at Olympia, the close down order was given and the world's first regular television service came off the air without a closing announcement, not to be recommenced until after hostilities ceased.

Television in Great Britain resumed service in June, 1946, and the first outside broadcast was indeed a memorable one, the Victory Parade. Since then television has steadily expanded, and the completion of five high-powered stations located at Alexandra Palace, Sutton Coldfield, Holme Moss, Kirk o'shotts, and Wenvoe are providing a service in England, Scotland, and Wales, and giving television coverage of approximately 87 per cent. of the population in these areas.

It was originally intended that these high-powered stations should be supplemented by additional low-powered transmitters, but the completion of the low-powered transmitters has been delayed for economic reasons.

The latest reports indicate that the British authorities are considered setting in train the machinery for the broadcasting of sponsored television programmes as distinct from the General Service provided by the British Broadcasting Service.

AMERICA

Television transmissions in American began in 1939, but like Britain, these were interrupted by the war, although North American transmissions continued into 1941. Post-war television recommenced in 1946 with seven stations in operation, and these have now been increased to the present number of 111 stations operating in 64 different cities, and serving 62 per cent. of the population. The normal growth of increase in the number of television stations was retarded by the "freeze" imposed by the F.C.C. between September, 1948, and July, 1952. Since July, 1952, a total of 73 television station construction permits have been issued by the F.C.C., 10 to educational institutions, and 63 to commercial interests.

At the present time there are over 700 applications for television station construction permits being considered by the F.C.C. It is estimated that by the middle of this year a total of between 200 and 300 television station construction permits will have been issued, and approximately 600 stations will be on the air. This goes to show what big business television really is in America, and although a little behind the United Kingdom in commencing service, the ramifications of television in America are now much more widespread. This can, to a degree, be considered attributable to the fact that sponsored programmes are the order of the day in North America.

OTHER AREAS

We could enumerate progress which has been made in continental Europe, South America, and the East, but suffice to say that all major countries are appreciating the fact that television is an essential in the national

make-up, and all are either experimenting or about to open experimental transmitters. As we all know, experimental transmitters pave the way for a more permanent service. Experimental transmissions have already been made from Canterbury University College in Christchurch, and while both Australia and New Zealand at the moment do not seem to be making material progress, we are confident that both countries will in the foreseeable future have television transmissions. The foundation on which sound television trading is built is "service." Positive steps have already been taken in this direction. We have already mentioned Canterbury University College, and its activities are widely known among those who have been following television research in New Zealand. Possibly not so well known is the fact that the Seddon Memorial College, Auckland, has a well attended and flourishing course of particular interest to servicemen. Wellington Technical College will in the immediate future be able to offer a course for those who wish to extend their knowledge on this subject.

TELEVISION IN AMERICA

We have now covered "television" in a very broad sense. Because of space considerations, the outlines given were often sketchy. Now we propose to deal with television in the United States in greater detail.

Progress: The clearest way to portray the remarkable progress of TV in the United States of America is to give some statistics which will speak for themselves.

TV sets in use May, 1952	17,600,000
TV sets in use December, 1952	21,000,000
Increase in receivers in seven months	3,400,000

Selling 3,400,000 TV sets in seven months makes one gasp—but the rapid growth of TV wherever it has been transmitted has always surprised the most optimistic. By 1956, it is estimated that the number of sets in use will be doubled (over 40,000,000 sets) and there will be a viewing audience approaching one hundred and fifty million people. By that time, the country will be served by over six hundred stations. Profits from operating TV transmitters have sharply increased and whereas originally most stations were operating at a loss an overall gross profit of forty-four million dollars was achieved in 1952.

Price: Information recently given by William Balderton, President of Philco Corporation in an address at the George School, Newton, P.A., covers price tends in a graphic manner. The address incidentally was given wide publicity in American trade magazines. Mr. Balderton recalled that the first table model receiver produced by Philco employing a ten inch tube retailed at 445 dollars. The latest production employing a seventeen inch tube retails at 229 dollars including antenna. The seventeen inch tube provides a picture three times larger than the ten inch tube.

Briefly, the cost of an improved receiver which gives a picture three times as large as its counterpart available five years ago costs *half* the price.

Transmissions: The post-war era has seen no outstanding technological developments in America's transmissions. The system used is 525 lines as against 405 lines of the B.B.C. While the theoretical difference is 120 lines, in practice the difference is approximately 100 and the resultant improvement in picture received is comparatively insignificant. As compared with Great Britain the emphasis is on a large number of medium and relatively low-powered transmitters as compared with a few high-powered transmitters linked to transmit a single programme. People in London have a single programme transmitted from Alexandra Palace. We set out below a comparison.

	Stations
London	1
New York	7
Los Angeles	7
Washington	4
Philadelphia	3
Detroit	3
Baltimore	3
Cincinatti	3

The main reason for the difference between Great Britain and the U.S.A. is that television transmissions in the U.S.A. are commercial and the programmes are sponsored or revenue producing. There is also the fact that the single British programmes can achieve substantial coverage from their five high-powered transmitters over the substantialy smaller but more densely populated territory.

Finance: As has already been pointed out, in U.S.A. transmission revenues are secured from sponsors, or advertisers. Television is considered to be the most effective and efficient media of advertising particularly where a product demonstration is advantageous. Hours of service and quality of programmes are therefore determined by advertiser demands. This again contrasts with the United Kingdom where transmission and programme costs are met from licence fees. Hours of service and programme costs are therefore related to revenue from licences.

(Continued on page 44.)

NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

This section of our paper is reserved for the introduction of new products and space preference is given to our regular advertisers. Advertising rates are charged according to space occupied. For further particulars contact Advertising Manager, R. and E., Box 8022, Wellington.

THE NEW PYE "65"—A DUAL-PURPOSE RADIO

This latest model in the Pye range is a combined mantel and portable radio. It is more than just an ordinary portable, although it can be operated from A.C. power or its own batteries.

Used as a mantel radio, the "65" gives full 7-valve performance that compares more than favourably with any 7-valve mantel on the market today.

The cabinet has been designed so that the set is acceptable in the home as a mantel model, while the portable aspect has not been forgotten in designing the model "65" for comfortable carrying. The carrying handle itself is retractable, and is invisible when not in use.

The Pye model "65" features an 8 in. loudspeaker and performance, both as a mantel model and a portable is truly outstanding. The very attractive cabinet is of metal and moulded plastic in toning colours grey and blue.

Pye predict that the "65" is going to be a volume seller at a retail price of £35 17s. 6d.

Pye radios are distributed throughout New Zealand by Pye (New Zealand) Ltd., Box 2839, Auckland.

Letters to the Editor

Mr Stagpoole Replies

Sir,—I should like to thank Mr. M. E. Pattinson through your columns for his interesting letter. It is almost inevitable that in condensing large masses of data into a few thousand words that certain ambiguities should creep in, and I would like to answer some of the points raised.

In discussing transients we are apparently talking about different things.

A transient can be defined as something which occurs once only within a specified time, relatively long with respect to the event, or is repeated at irregular intervals. A square wave obviously does not fall within this definition. This statement may at first seem rather odd, as at first glance a square wave looks like a whole series of transients—but is it? It is well known that square waves are capable of analysis into a fundamental sine wave plus a theoretically infinite series of odd harmonics *all* of which are *continuously* present. The only transient concerned is at the actual beginning (in time) of the wave. It should then be apparent that square wave testing of microphones is a good test of frequency range and little else.

The only test of transient response then is a source in which all frequencies are present simultaneously, i.e., a noise source. This means that the microphone is being continuously excited over a wide band in a non-sinusoidal manner. Under these circumstances condenser microphones show about 15 db. more output than ribbon microphones, after being set to equal levels on tone. This is not due to resonances in the condenser microphones as can be shown by watching its output on an oscilloscope. In the face of this evidence it is difficult to see on what grounds the proponents of ribbon microphones claim good transient response.

We are placed in a position where we must accept the square wave tests made by Olson and Preston for R.C.A. in 1946, or the noise tests made by Cook in his laboratories in 1949. Irrespective of our beliefs it is an incontestable fact that the condenser microphone is capable of better results than the ribbon. This is attested to by the fact that R.C.A., the largest manufacturers of ribbon microphones, have recently changed to Telefunken condenser microphones for their commercial recording.

With regard to transient response and mechanical resonance, your correspondent believes that these are not necessarily connected. Let us look at it this way. In a mechanical resonant system the velocity of movement of the free end is proportional to the applied force, below resonance. It is well known that above resonance it is necessary to apply considerably greater force to maintain a constant velocity; the movement in effect becomes stiff.

Let us now take a microphone (or cutterhead) which maintains constant output (or recording velocity) above its resonance for a fixed input force. Obviously it can only do this by building up to this peak level over a period of time storing energy unused from each cycle, because at any one instant the impressed force will be only sufficient to give full amplitude *below resonance*. Older moving iron cutters had resonances in the region of 5 kc/sec. A track cut at 10 kc/sec. would replay at the same amplitude, but if one cared to look at the disc through a microscope it would be seen that the modulated groove took an appreciable time to reach full amplitude. A clear example of falling transient response.

On the subject of negative feedback and amplifiers, your correspondent reaches the same solution that I implied (though I did not state it) in the article concerned, that is that the frequency range must be restricted. Here we are in good company—that of Mr. H. J. Leak who recommends a range only sufficient for the needs at hand, i.e., 5 cycles to 20 kc/sec. for an audio amplifier.

With regard to low resonance in loudspeakers limiting transient response, Mr. Pattinson seems to have forgotten that all loudspeakers exhibit "break-up" and in practice have resonances at many different frequencies. In fact Mr. H. A. Hartley, a well known speaker manufacturer, stated in a recent *Audio Engineering* that a speaker cone which was perfectly rigid (that is, displayed

only one resonance) would only produce a sine wave.

Manufacturers take care to ensure that the high frequency cone is not tightly coupled to the main cone so that it will in fact operate at high frequencies. That ribbon type microphones are somewhat better in practice than in theory may also be due to "break-up."

Users of the R.J. enclosure will disagree with Mr. Pattinson when he says that it has no advantages over the conventional phase inverter enclosure. Briefly these are (1) small physical size, (2) improved cone damping resulting in lower cone resonance and extended bass. In practice the box is lined with felt, a fact which was not made apparent in the article. Oscillograms of a conventional 12 in. speaker show production of pure sine waves at 32 c.p.s. in an R.J. where the same speaker in the bass reflex enclosure produces 64 c.p.s. when supplied with 32 c.p.s.

I am surprised at the statement that distortion can produce an apparent lack of bass. It has always been my impression that distortion at low frequencies appears to improve bass response. Some years ago *Wireless World* ran an article on a device which simulated true bass by adding harmonics produced in a distorter to the low frequency speaker.

With regard to lack of bass and the general quality of L.P.'s versus S.P.'s, it is largely a matter of opinion. There is no question that some records have much better bass, transients, etc., than others. Your correspondent can be assured that these sound good on most systems to which I have access. Other records are just not so good. I would agree that some L.P. faults can be attributed to the reproducing pick-up—but not tape flutter, tape thumps, excessive recording levels, inner groove distortion, or just pain missed notes due to tape cutting.

I am perhaps at a slight advantage in the matter of L.P. reproduction as I have access to some hundreds of L.P.'s and reproducing equipment probably second to none in this country, "so I know whereof I speak." I can assure your readers that the facts used in the series of articles were obtained from reputable radio journals and although they may be open to various interpretations, no amount of argument will alter facts. Such facts that condenser microphones, R.J. enclosures, and some recordings sound better.

V. M. STAGPOOLE.

TELEVISION ROUND THE GLOBE

EMITRON 16 mm. FILM SCANNER FOR THE B.B.C. TELEVISION SERVICE

Emitron Television Ltd. have recently supplied a new 16 mm. film scanner to the B.B.C. This new E.M.I. equipment supplements the 35 mm. Emitron film channels already in regular use at Alexandra Palace. A notable feature of this 16 mm. film scanner is the continuous motion drive, the many difficulties associated with the adaptation of this method to 16 mm. work having been overcome with complete success by E.M.I. engineers. Either married or unmarried picture and sound prints, and either negative or positive films may be used, the necessary phase reversal being effected in the electrical circuits. Provision is made for continuous loop running for test purposes, etc. Automatic compensation for film shrinkage is incorporated. In addition to the normal optical sound head, the projector is fitted with a magnetic head for the reproduction of sound from magnetic tape recordings.

* * *

The opening of the National College of Rubber Technology in London recently provided the opportunity for the demonstration of a novel new method of teaching students, using Pye industrial television equipment. After the installation of the industrial camera in the rubber shop on the ground floor, the audience of 180 viewed pictures on a Pye 27-inch monitor installed in the lecture theatre. Details of the processes and machinery which normally could be seen by only four or five students at a time were televised from the rubber shop to the audience in the lecture theatre, and questions asked there were answered by means of a talk-back system, the answers being illustrated by demonstrators in the rubber shop.

In addition to the main rubber shop, all the main laboratories at the college have been wired for television.

The entire equipment for the generation and control of the television image is contained within a single small camera case. Only two connections are necessary—viz., mains input and either low-level video output or an R.F. output, tunable over the normal B.B.C. channels.

Normally, the complete equipment, which costs less than £1,400, comprises a camera with a 1 in. focal-length lens, a camera pedestal, and a 14-inch monitor, complete with stand.

* * *

INTERNATIONAL TELEVISION

The possibilities of using television as a powerful influence in promoting good international relations are manifold. Recently a conference was held between broadcasting organizations of Britain, France, Belgium, Holland, and the German Federal Republic to discuss a proposal for the exchange of television programmes during the Christmas period. Also on the agenda were plans for the establishment of permanent television links between the countries concerned.

* * *

STEREOSCOPIC TELEVISION

The American Broadcasting Company in Hollywood recently demonstrated stereoscopic television, the system used being a synchronized mirror rotating 30 times per second in front of the television camera to produce two images with an apparent spacing equivalent to that of the human eyes. These were reproduced on separate C.R. tubes at the receiver, and projected on to a screen 3 ft. by 4 ft. The audience, wearing polarized spectacles, found the results strikingly effective.

According to our American contemporary, "Radio-Electronics," the Radio Corporation of America is working on a "three-dimensional" television system using a wide-angle camera lens, giving a 142-degree field of view, and a spherical-screen projection receiver. Presumably this is the television equivalent of the film industry's "Cinerama" or "Cinemascope,"

USING THE HARMONIC SIGNAL GENERATOR

(Continued from page 16.)

ALIGNMENT OF BANDSPREAD SETS

In factories where bandspread receivers are built, it is quite standard practice for the bandspread ranges to be aligned with the aid of just such a harmonic signal generator as we have been describing. The bandspread ranges are usually calibrated at least in hundreds of kilocycles, and it is quite impossible to set a tunable signal generator with the accuracy required for checking the alignment of this type of set. For this job, the 100 kc/sec. series of signals is used, after initial alignment with the 1 mc/sec. series, and, as long as the oscillators are on their exact frequencies, the harmonic signals are precisely correct, and enable the dial alignment to be checked in a way that could not be done otherwise.

TRADE WINDS

(Continued from page 35.)

frequency stability. His grasp of sound principles of mechanical and electrical design was a great advantage. He worked in London and Poldhu until 1925. During this period the transmitters for the Beam contract were designed and the advantages of directional aerials were established.

Between 1926 and 1928 he installed beam transmitters in Canada and the United States.

Mr. Hall then returned to Chelmsford to take up the work of designing short-wave transmitters under the direction of Mr. Franklin. This was his main work during the next twelve years, and produced the line of SWB transmitters of which SWB8 and SWB11 are the best known. He installed a short-wave radio-telephone set in the s.s. *Homeric* (1929) and later (1932) in the Italian liner *Conte Rosso*.

In 1943 he was loaned to the Admiralty for research work, returning to the Marconi company in 1946, first being attached to the Engineer-in-Chief for miscellaneous duties, and then to the Technical Information Division, where he was in charge of a liaison section responsible for interchange of technical information with American associates, and where he remained until his illness in January, 1953.

HISTORY OF TELEVISION

(Continued from page 39.)

PROGRAMMES AND STUDIO TECHNIQUES

As one would expect, television has borrowed much from Hollywood in the matter of light usage and equipment. The Orthicon camera used in U.S. equipment is more sensitive than the tube used by the B.B.C. Nevertheless, a high light level is maintained in the studios enabling camera lenses to be stopped down to as low as F1, producing a picture with a good depth of field.

The Zoomar lens is extensively used and can be classed as one of the greatest post-war advances in televising. Developed by Dr. Frank Back, the well-known optical expert, it makes it possible for the operator to follow "action" anywhere on a football field and show the audience a close up shot every time. The construction of the lens allows the operator to "Zoom" the lenses after the ball or player so that the home viewer has a better and closer view than if he were at the match.

American programmes usually consist of thirteen minutes of feature and two minutes of station identification and commercial. Thirty minutes is considered the maximum desired except in special circumstances. The type of programme is naturally one that will attract the widest interest and hold the largest number of viewers. Like the commercial radio stations in New Zealand, they cater for the mass rather than for the "few." The reason is obvious, they live by the results their sponsors consider they achieve.

COLOUR TELEVISION

Several systems have been demonstrated and at least three are technically suitable. The main issue, however, does not hinge on the technicalities of the system. The major issue is that of being able to receive a transmission in colour on a standard receiver (black and white) without modifications. It is possible that one system now under final tests will do this.

The American broadcaster depends on his audience size for revenue and anything which will decrease his audience—such as the introduction of transmissions which a large part of his audience cannot receive—decreases his income. This is obviously highly undesirable.

AN EASILY CONSTRUCTED MULTIMETER

(Continued from page 7.)

enough information in this article to enable him to do so. This should be found a very useful instrument, for both amateur and professional alike. For the latter, it may pay him to build this circuit provided he has one good commercial instrument, because the home-made meter can be used as a knock-out everyday instrument, leaving the commercial one as an accurate standard of comparison, which will no longer be subject to the bumps and temporary overloads all meters are bound to get in everyday use.

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RADIO AND RADAR FOR NEW TRAWLER

Trawlers nowadays are fitted with the most up-to-date radio and radar equipment. The latest addition to the North Cape fishing fleet, the *St. Bartholomew,* went to sea complete with radar and other communication equipment fitted by the Marconi International Marine Communication Co., Ltd. ...

For speech or morse communication with other vessels and ship-to-shore working, in addition to providing a link with shore telephone services, she carries a "Transarctic" transmitter/receiver.

"Radiolocator IV" radar, a "Lodestone" direction-finder, a "Seapilot" direction-indicator, and a "Seagraph" recording echometer are fitted to aid navigation in all conditions of visibility, while a "fischlue" fish-indicating echometer is provided to work in conjunction with the "Seagraph" as an aid to fishing.

An "Oceanic" sound-reproducing system which includes talk-back facilities is also installed.

BINDERS FOR "R. & E."

These are available to hold 12 issues—price 5s. 6d.

NOW 3 SPEEDS

Connoisseur

present an entirely new 3 speed Gramophone motor

Now—all the advantages of Connoisseur plus an extra speed. Operates at $33\frac{1}{3}$, 45, and 78 r.p.m. Full 12-inch turntable—precision-ground main spindle runs in phosphor bronze bearings—dynamically balanced synchronous motor is virtually vibrationless, with low noise-level and hum induction. Plays standard transcription and microgroove recordings. Mounted on $\frac{1}{4}$ in. plastic board, $15\frac{3}{4}$ in. x $13\frac{1}{2}$ in., with $3\frac{3}{4}$ in. clearance distance below motorboard.

THE Connoisseur

SUPER LIGHTWEIGHT PICK-UP

Three bayonet-action interchangeable heads, ensuring faithful reproduction under all circumstances. Extremely low mass at needle-point, allowing reduction in downward pressure to 8-10 grams for standard recordings and 4-6 grams for microgroove recordings. Frequency range, 20-15,000 c.p.s. Ideal instrument for dubbing work on nitrocellulose discs.

Available with or without screened step-up transformer.

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